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Volume IV of this final report is a synopsis of the Civil GPS User Workshop held 22 September 1987 in Colorado Springs, Colorado. The purpose of this workshop was to provide a forum whereby the civil GPS user could review and comment on the data to be made available to the civil community. Overviews were presented by the U. S. Air Force, Applied Research Laboratories, The University of Texas at Austin (ARL:UT), and the Department of Transportation (DOT). Technical discussion groups representing five civil GPS user interest groups were chaired by members of the Civil GPS Service (CGS) steering committee. These groups obtained direct inputs from the civil users. This volume includes transcripts of the oral presentations and summaries of the five discussion groups.

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3.

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18.

Global Positioning System (GPS),
Civil GPS Service (CGS)
~~Civil GPS Information~~ Center (CGIC)
Joint Program Office (JPO),
interface control document (ICD),
time frequency communications,
surveying geophysics, (SDW)
navigation: aviation/aerospace
navigation: marine
navigation and positioning: land

TABLE OF CONTENTS

PREFACE

This is the final report for work conducted by Applied Research Laboratories, The University of Texas at Austin (ARL:UT), under Contract N00024-86-C-6134, Task 12, Project 18, under the technical instruction entitled "Incorporation of the Civilian Community in GPS Operation Capability Reporting System Study". This report is in four volumes. One of the primary efforts associated with this contract was the development of an interface between the U.S. Air Force and the civil community which will allow the civil community access to information regarding the navigation status of the Global Positioning System (GPS). This interface, or point of contact, operated by a civil organization and referred to as the Civil GPS Service (CGS), will serve as a source of information from the GPS Operation Control Segment (OCS) and other sources, and disseminate that information to the civil community. The Civil GPS Information Center (CGIC) will serve as the operational arm of the CGS by providing GPS status information to the civil community.

Volume I. "Determination of the Requirements of the Civil GPS User Community," by Brent A. Renfro.

Volume I summarizes all efforts performed by ARL:UT in meeting the specific tasks described in the contract. These include

(1) establishing a steering committee,
(2) determining needs of GPS civil users,
(3) determining data and data sources which are, or will be, available to the CGS,
(4) conducting a CGS user workshop, and
(5) developing a system design for data distribution.

Volume II. **"Appendices to Volume I," by Arnold J. Tucker, Brent A. Renfro, and Jeanne L. Williams.**

Volume II, a compendium of appendices, addresses the results of the above tasks in greater detail.

Volume III. **"Interface Control Document for the Civil GPS Service Interface to the OPSCAP Reporting and Management System," by Patrick R. Pastor.**

Volume III is the interface control document (ICD) defining the requirements related to the transfer of GPS navigation data between the Operational, Status, and Capability (OPSCAP) Reporting and Management System (ORMS) and the CGS.

Volume IV. **"Synopsis of Civil GPS User Workshop (22 September 1987)," edited by Arnold J. Tucker.**

Volume IV is the synopsis of the GPS Civil User Workshop held on 22 September 1987 in Colorado Springs, Colorado. Included in this synopsis are transcripts of the oral presentations made during the General Session and also summaries from the various discussion groups which were chaired by members of the CGS Steering Committee.

For additional information regarding the CGS, direct queries to the following address.

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ATTN DRT-1
400 7th St., S.W.
Room 8405
Washington, D.C. 20590

I. INTRODUCTION

A study is being conducted by Applied Research Laboratories, The University of Texas at Austin (ARL:UT), to define a Civil GPS Service (CGS). This task is being guided by a steering committee composed of representatives from several user communities interested in the GPS system. The function of the CGS is to serve as a source of information about the GPS system and a point of contact for civil users of GPS. The Civil GPS Information Center (CGIC) will accept information regarding GPS status and capability from the GPS Operational Control Segment (OCS) and other sources and disseminate that information to the civil community as a complement to NOTAMS and Notices to Mariners. It will also serve as a focal point for comments and questions from the civil community to Department of Defense (DoD) regarding GPS. The CGIC will not address the issue of determining GPS integrity in realtime, but will serve as a channel through which the OCS will pass information on GPS navigation performance to civil users as it becomes available.

A Civil GPS User Workshop was held on 22 September 1987 at the Antlers Hotel in Colorado Springs preceding the Institute of Navigation Satellite Division National Meeting. The purpose of this workshop was to provide a forum wherein the civil GPS user community could review the database to be made available by the Military OPSCAP and to provide specific comments on the types of data and the formatting of the data required by the civil community. Overviews of the current status of the Air Force policy, the Military OPSCAP, the CGS and CGIC, and Department of Transportation (DOT) planning were presented. Technical discussion sessions, representing five civil GPS user interest groups, were chaired by members of the CGS Steering Committee to obtain direct input from the civil user.

A synopsis of the overviews and summaries from each of the five technical discussion groups follow. Also included are the visual aid slides used by various of the speakers.

Some terminology used in this synopsis is no longer current. At CGS steering committee meetings following the workshop, several name changes were agreed upon and additional publications concerning the CGS reflect these changes. For clarity, these changes are noted below.

Organization Name Change

FROM	TO
Military OPSCAP	Operational, Status, and Capability (OPSCAP) Reporting and Management System (ORMS)

ICD Information Categories

FROM	TO
Near Realtime	Short Delay
Short Delay	Intermediate Delay
Post Facto	Long Delay

GPS CIVIL USER WORKSHOP AGENDA

8:30-10:15 GENERAL SESSION -- CARLTON/STRATTON ROOM
LCDR HANS KUNZE

USAF POLICY STATEMENT ON OPSCAP
COL. GENE COCO
OVERVIEW OF MILITARY OPSCAP
CAPT. MARK ERKKILA

CIVIL GPS SERVICE
GENERAL OVERVIEW
ARNOLD TUCKER
SUMMARY OF DOT PLANNING
RUDY KALAFUS
SURVEY RESULTS
BRENT RENFRO
INTERFACE CONTROL DOCUMENT
PAT PASTOR

OVERVIEW OF DISCUSSION GROUPS
LCDR HANS KUNZE

10:15-10:30 BREAK

10:30-12:30 DISCUSSION GROUPS (CHAIRMEN)

TIMING/FREQUENCY/COMMUNICATIONS -- LONDON FOG ROOM
DAVID ALLAN AND WILLIAM KLEPCZYNSKI

SURVEYING/GEOPHYSICS -- STRATTON ROOM
LARRY HOTHEM AND MICHAEL ELLETT

NAVIGATION/AVIATION/AEROSPACE -- CARLTON ROOM
KEITH MCDONALD

NAVIGATION/MARINE -- CHEYENNE ROOM
RICHARD HENDRICKSON

NAVIGATION AND POSITIONING/LAND -- FREMONT ROOM
DAVID SCULL

4:30-6:00 GENERAL SESSION -- CARLTON/STRATTON ROOM

DISCUSSION OF GROUP SUMMARIES
(DISCUSSION GROUP CHAIRMEN)

PURPOSE OF WORKSHOP

REVIEW PHILOSOPHY OF CIVIL GPS SERVICE

REVIEW DoD POSITION WITH CIVIL GPS SERVICE

REVIEW CIVIL GPS SERVICE

CONDUCT GPS CIVIL USER DISCUSSION GROUPS

FINALIZE CIVIL USERS REQUIREMENTS FOR
CIVIL GPS SERVICE INTERFACE CONTROL
DOCUMENT

GPS CIVIL USER WORKSHOP HIGHLIGHTS

- CGS SHOULD BE THE CIVIL POINT OF CONTACT AND SERVE AS AN ADVOCATE FOR CIVIL USERS

- CGS SHOULD PROVIDE A DATABASE LARGE ENOUGH TO HANDLE INFORMATION ON BOTH A GENERAL AND SPECIFIC BASIS, INCLUDING PUBLISHING GENERAL GPS INFORMATION

- CGS SHOULD PROVIDE TRACEABILITY OF DATA AND PROMOTE STANDARDS

II. GPS OVERVIEWS

USAF POLICY STATEMENT ON OPSCAP

COL. GENE COCO
GPS JOINT PROGRAM OFFICE

The U.S. Air Force Headquarters has not issued an Air Force policy in regard to the Operational Capability Reporting System (OPSCAP), but the GPS Joint Program Office (JPO) has a proposal for providing information to the civil community regarding the GPS system. This proposal consists of three points:

(1) determine civil user requirements,

(2) develop a security guidance, and

(3) identify data to be disseminated by the Military OPSCAP.

The information needed by the civil community has been and will continue to be determined. A GPS user survey, distributed by various interested groups, is an initial effort toward this goal. The user community should be encouraged to respond to this survey. The Department of Defense (DoD), the JPO, and Department of Transportation (DOT) will continue to solicit this information through various channels.

The security guidance needs to be accomplished in regard to the GPS data to be disseminated to the civil community. The JPO will take into consideration what that classification guidance is and how it affects the dissemination of information to the user community. This effort will be worked with DOT to ensure that the information that is requested is minimally restricted through the classification policy.

The majority of the data to be disseminated by the Civil GPS Service (CGS) will originate with the Military OPSCAP. This information will be disseminated to the civil community by the Civil GPS Information Center (CGIC) and will be available to the international community.

USAF PROPOSAL FOR PROVIDING GPS DATA TO CIVIL USERS

- STEP 1: DOT (CIVIL GPS SERVICE) IDENTIFIES DESIRED DATA TO DOD

- STEP 2: DOD REVIEWS DESIRED DATA, ALONG WITH SECURITY CLASSIFICATION GUIDANCE, AND DETERMINES WHAT DATA CAN BE PROVIDED TO CIVIL USERS

- STEP 3: DOD (MILITARY OPSCAP) PROVIDES AUTHORIZED DATA TO CIVIL USERS VIA NOTAM SYSTEM/NOTICE TO MARINERS SYSTEM AND VIA CIVIL GPS INFORMATION CENTER

OVERVIEW OF MILITARY OPSCAP

CAPT. MARK ERKKILA
GPS JOINT PROGRAM OFFICE

The following presentation is a top level overview of the Military Operational Capability Reporting System (OPSCAP) -- why the Military OPSCAP is needed, its architecture, and how it interfaces with different users (Slides 1 and 2).

The Global Positioning System (GPS) is composed of many elements (Slide 3). By current design, 18 Block II satellites will be deployed with three on-orbit spares and a number of surviving Block I satellites. Each satellite has 11 subsystems. In addition to the satellite constellation, the GPS system has five monitor stations located at Ascension, Diego Garcia, Kwajalein, Hawaii, and the Consolidated Space Operations Center (CSOC) in Colorado Springs.

Three ground antennas (GAs) co-located with the monitor stations (MSs) at Ascension, Diego Garcia, and Kwajalein are used for communications with the GPS spacecraft vehicles (SVs). The Cape facility in Florida is used primarily for redundance as well as testing. Connecting the five monitor stations and three ground antennas is an extensive network of ground and satellite communication links. These communication links are tied directly to the Master Control Station (MCS) at Falcon Air Force Station here in Colorado Springs. At the MCS a pair of IBM 3083s is used to maintain a current database on the GPS satellite constellation. From that database, a Kalman filter estimates clock parameters (both time and frequency) and predicts satellite ephemerides.

Since the GPS system is a built-to-budget design system, there will be areas of degradation around the globe that will last as long as ten minutes. The purpose of OPSCAP is to keep track of these areas of degradation and to send that information out to users. Also, special

users have levied requirements upon the Joint Program Office (JPO) that need to be supported via the OPSCAP system.

The status, performance, and current configuration of the different elements in the GPS system are partially assessed by the MCS. Air Force managers have deemed it prudent to acquire a new computer, called the OPSCAP Processor, to take information from the MCS database, apply its own disciplines to it, reformat it, store it in the OPSCAP data trunk, and send it out to civilian, military, or government interfaces (Slide 4). Also the OPSCAP Processor will assist the primary user, the MCS operators who actually maintain the GPS constellation. OPSCAP will improve their ability to monitor the status of the different GPS subsystems. With OPSCAP it will be possible to simulate the effects or consequences of projected situations, e.g., the effect on navigation services if a satellite is taken out of orbit or rephased within the orbit.

In addition to providing 2D and 3D navigation accuracy, the OPSCAP Processor is also designed to provide status, configuration, and performance measures of the different subsystems both quantitatively and qualitatively in terms of green, red, or yellow declarations. For security reasons, the OPSCAP Processor and Preprocessor will be one integrated system located next to the MCS at Falcon AFS. From an environmental point of view, the OPSCAP Processor is located downstream of the OPSCAP Preprocessor which takes data from the Operational Control System (OCS) (Slide 6). OPSCAP also imports data from external sources such as the Defense Mapping Agency (DMA) which supplies information such as geodetic models and local datums. After performing internal OPSCAP processing functions, the data are exported out to external users. This export is constrained by Air Force policy as discussed by Col. Coco in his earlier presentation. It is envisioned that the exported data will go through a security monitor, which remains to be designed, to filter out classified data.

Once the exported data passes through the security monitor it will go to different user nodes -- military, government, or civilian. The information will be sent out according to a bit pattern, frequency and coverage specified by a particular node's Interface Control Document (ICD). For civil users that node is the Civil GPS Information Center (CGIC), which is part of the Civil GPS Service (CGS). The CGS's ICD should be a combination of the GPS Civil User's Survey results and discussion among different agencies on what information a civil user needs to perform their mission.

The Military OPSCAP is a multilevel reporting capability system, (Slide 6) with lower levels being more in-depth than higher levels. At the top level, the GPS managers will be able to determine in realtime whether a satellite or monitor station is designated red, green, or yellow. Yellow indicating performance is degraded but adequate, green indicating all systems are operating correctly, and red indicating a severe error condition.

To civil GPS users, OPSCAP will provide navigation service information. The vehicle for this service will be the Civil GPS Service which is the new designation for the older Civil OPSCAP system. All of the different levels of OPSCAP will be occurring currently in time (Slide 7). GPS information will be able to be retraced from an historical point of view and in a future sense, in addition to a simulation capability which will allow the determination of effects or consequences of projected situations.

The OPSCAP philosophy (Slide 8) is to provide navigation service to all users. OPSCAP will perform this by monitoring the status, the configuration, and the performance of each GPS subsystem. For example, the status of the GPS satellites, the master monitor stations, the ground antennas, and the communication links.

OPSCAP will also be able to access the navigation service in a global context, i.e., the system performance. OPSCAP (Slide 9) has the capability to take historical data and perform its own assessment as to whether a component would be declared red, green, or yellow. For instance, assessing the performance of a satellite clock that has been fluctuating every six hours for the past six months. OPSCAP can also determine satellite orbits (current or predicted) using either current states or current time simulation. In order to support all these capabilities, a large amount of MCS database information is required.

For the past several months, the Civil GPS Steering Committee has been analyzing the information needs of civil GPS users. Slide 10 indicates what user information has been identified at this time. This information is a subset of what the Military OPSCAP can provide; but this subset does not yet reflect security or Air Force policy constraints. Only pertinent information should be sent out to users. In short, there has to be a limit to the amount of information going to external interfaces to minimize the assessment of the GPS system by potential adversaries.

GLOBAL POSITIONING SYSTEM OPERATIONAL CAPABILITY (OPSCAP) REPORTING SYSTEM

CAPT. M. ERKKILA

GPS JOINT PROGRAM OFFICE

22 SEP 87

SLIDE 1

GPS OPSCAP

NEED

ARCHITECTURE

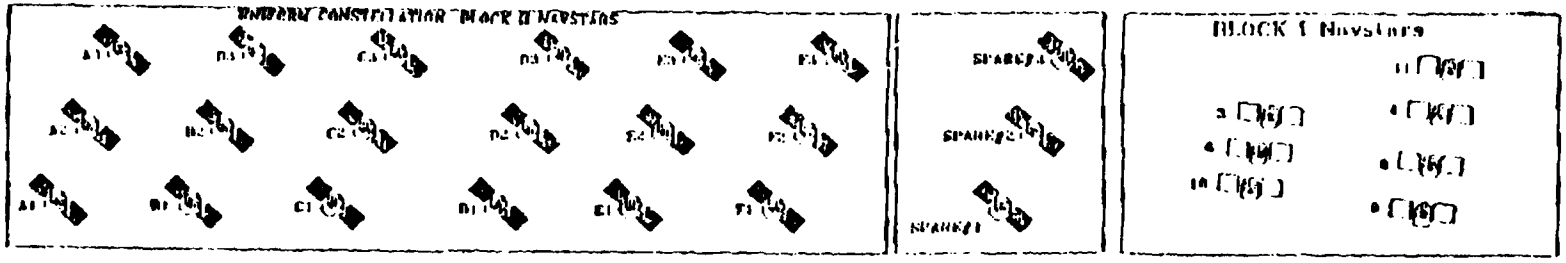
FUNCTIONS

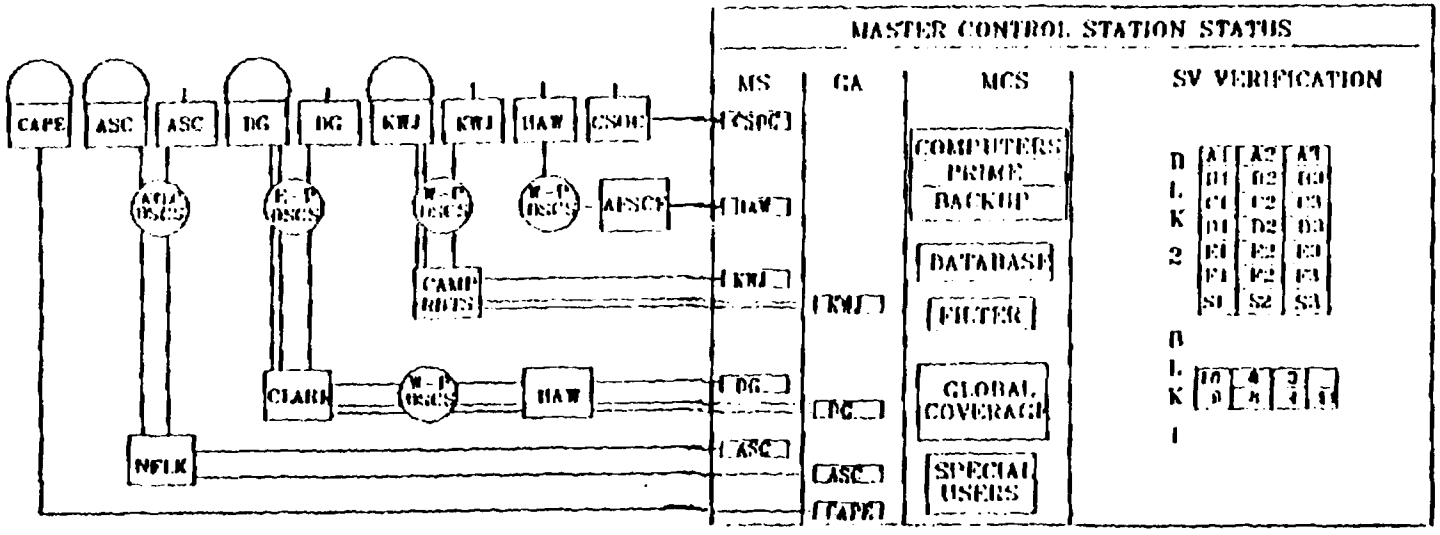
USER INTERFACE

SLIDE 2

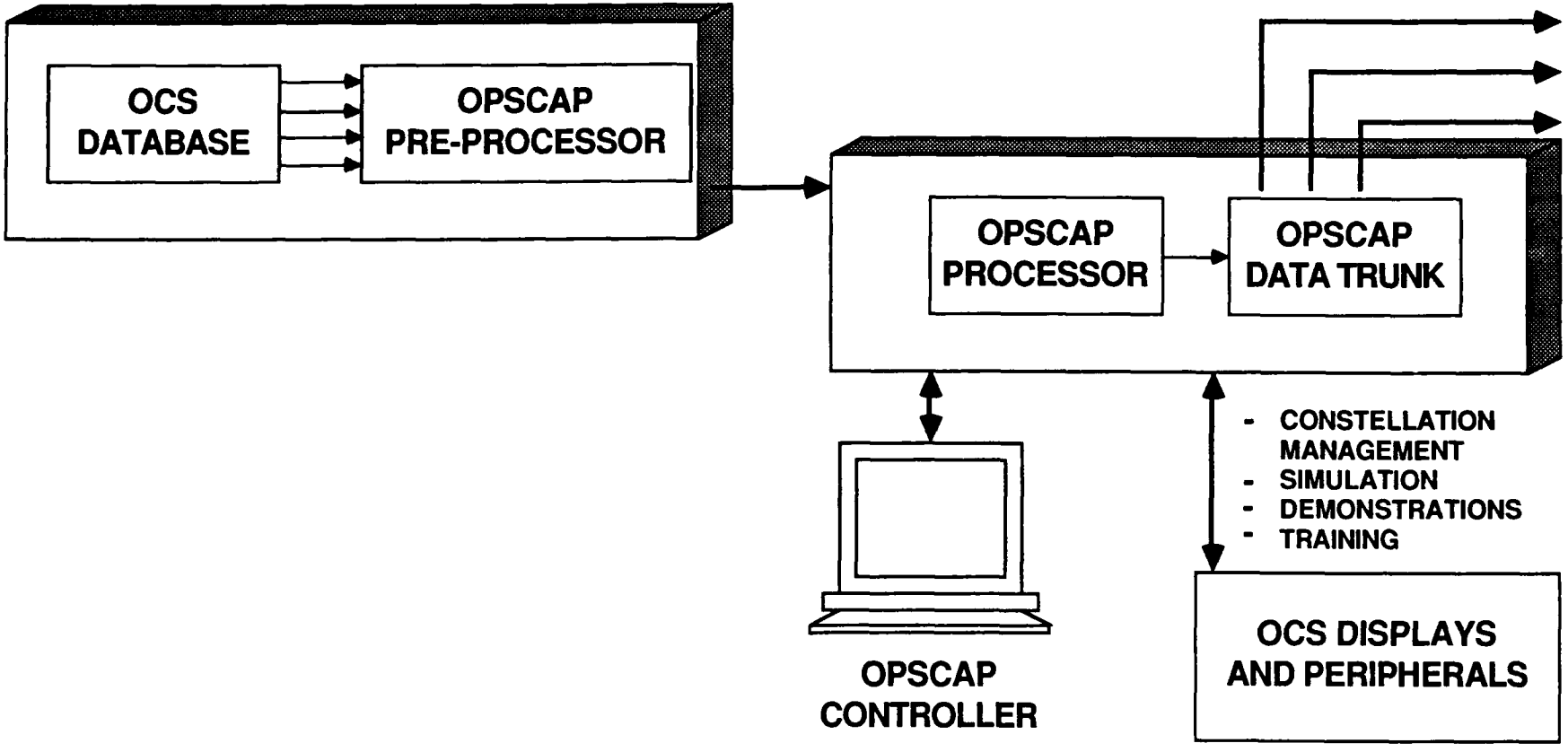
GPS

Component System Status

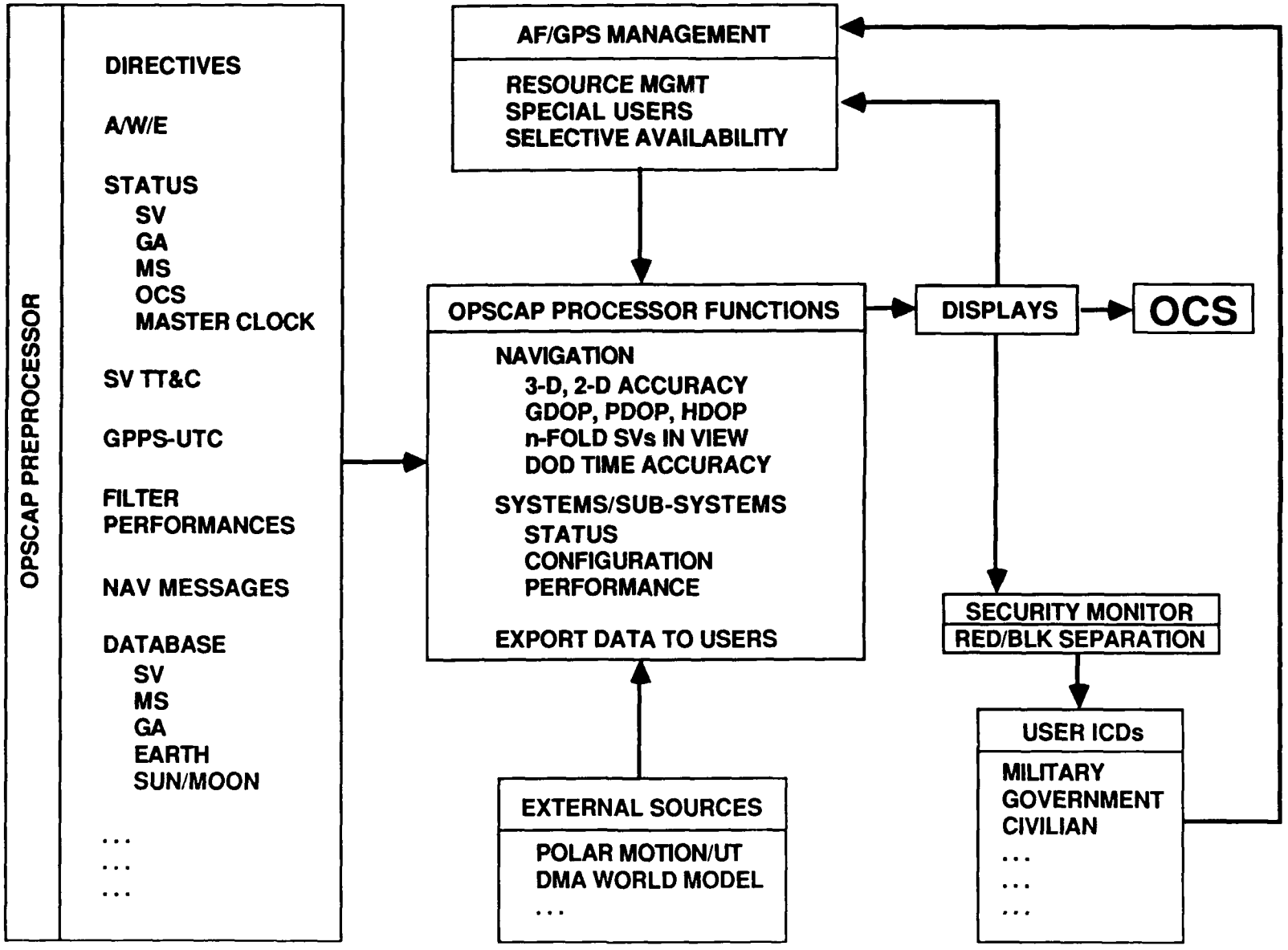




OPSCAP ARCHITECTURE



OPSCAP PROCESSOR ENVIRONMENT



(OVERVIEW)

OPERATIONAL CAPACITY

THE OPSCAP IS A HIERARCHICAL DISPLAY SYSTEM OF GPS PERFORMANCE CAPABILITY

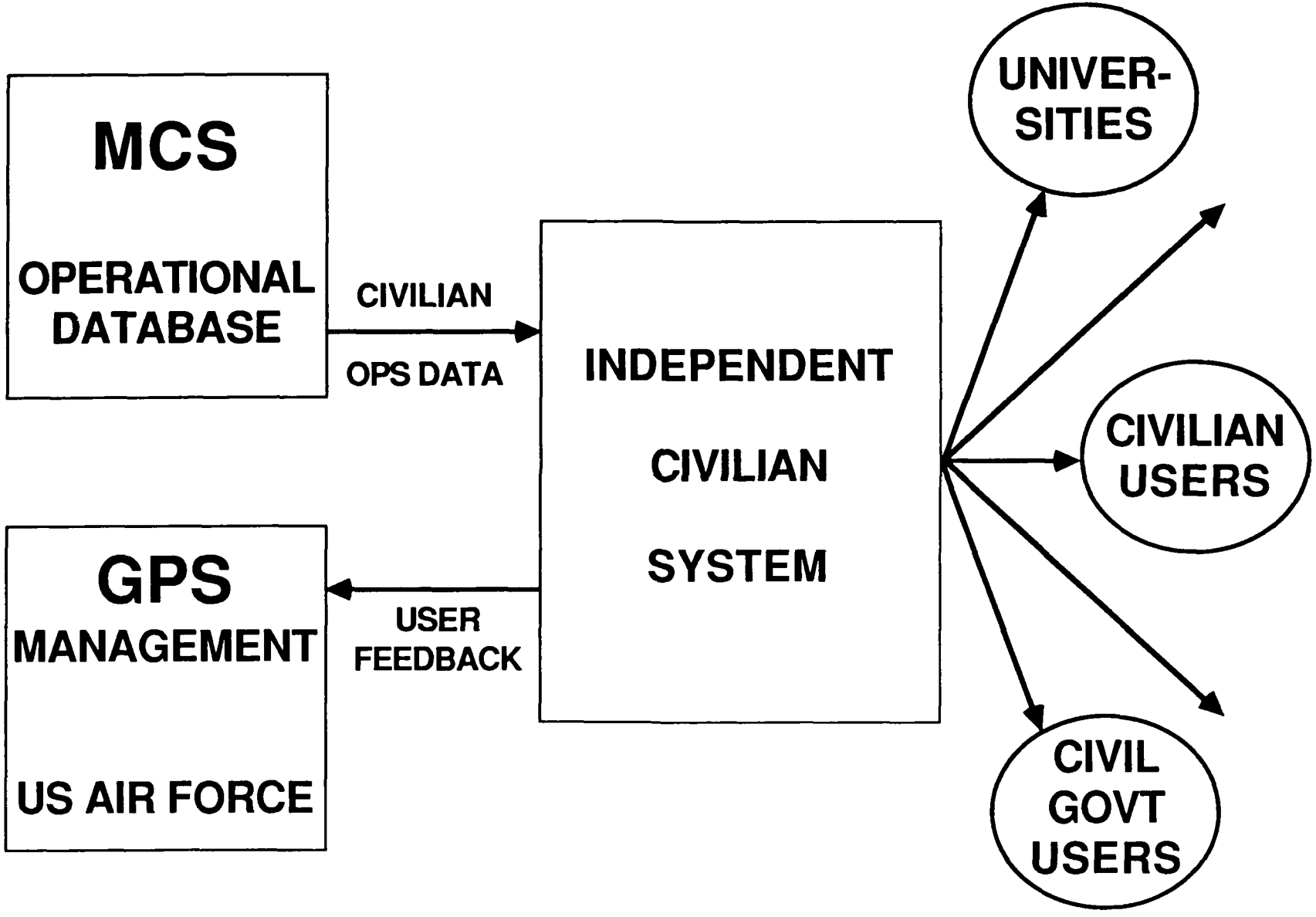
TOP LEVEL: MANAGEMENT OVERVIEW

SUBSEQUENT LEVELS: OPERATIONS MANAGEMENT

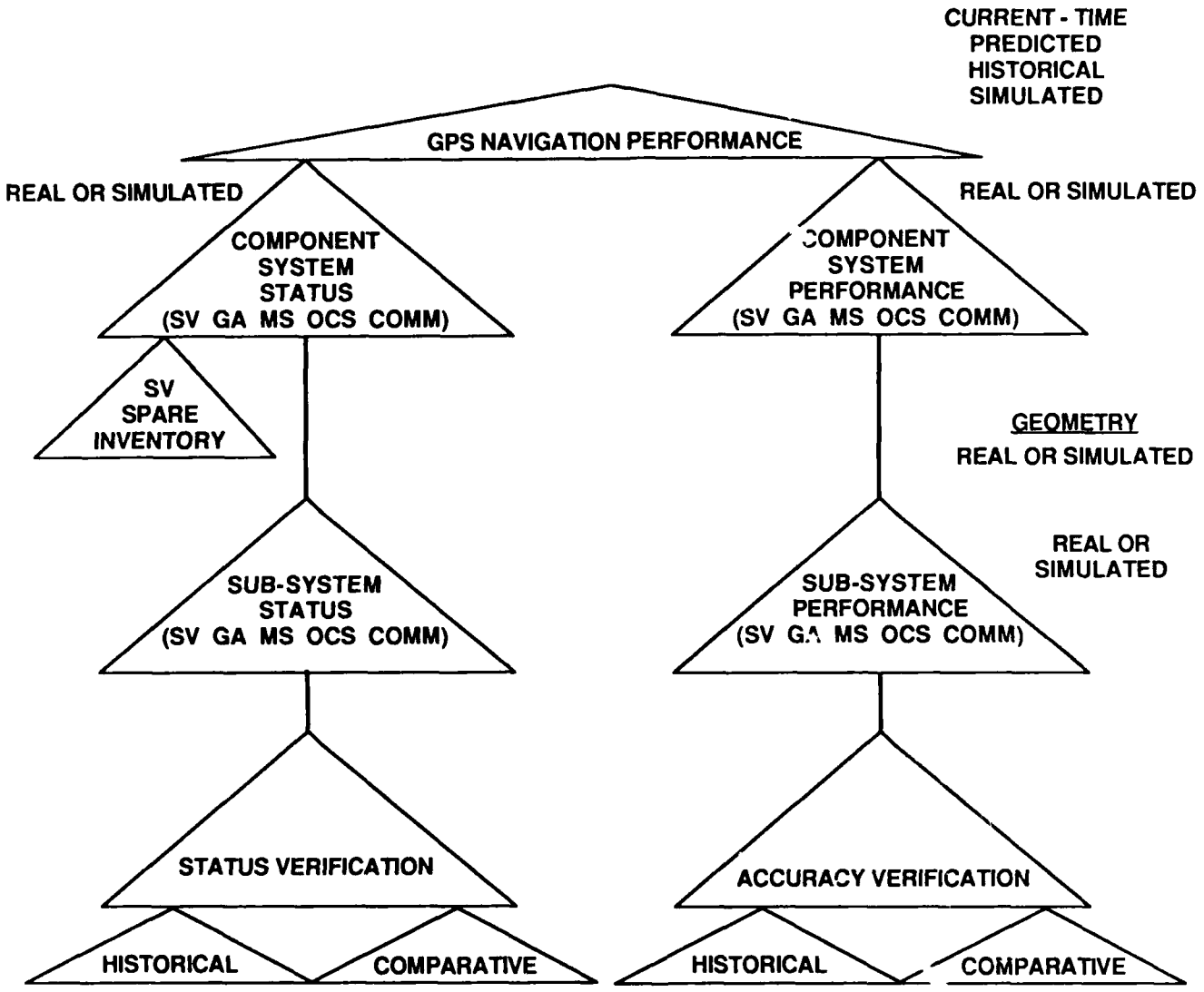
SUBSEQUENT LEVELS: GPS-TO-USER REPORTS

CURRENT-TIME
HISTORICAL
PREDICTED
SIMULATED

GPS CIVILIAN OPSCAP CONCEPT



OPSCAP FUNCTIONAL PHILOSOPHY



SLIDE 8

OPSCAP PERFORMANCE DATA

(GPS OPERATIONS USE)

STATUS
- GPS

NAV SERVICE EVALUATION
- GLOBAL COVERAGE
- S/A SETTING
- 3-D RMS ACCURACY (S/A)
- 2-D RMS ACCURACY (S/A)
- DCD TIME TRANSFER ACCURACY (S/A)

STATUS
- COMPONENTS: SV, GA, MS, OCS, COMM.
- NAV MSG VERIFY
- ORBIT/CLOCK FILTER CURRENCY
- ACTIVE: SV-MS / SV-GA LINKS
- SCHEDULED: SV-MS / SV-GA LINKS
- CONSTELLATION FILL

PERFORMANCE
- MS NAV ACCURACY
- GLOBAL RMS URE
- KALMAN FILTER ERD
- SV-MS RMS ORD
- LONGITUDE OF ASCENDING NODE

STATUS
- SUB-SYSTEMS: SV, GA, MS, OCS, COMM.

SUB-SYSTEM INVENTORIES
- SV, GA, MS, OCS, COMM.

ACCURACY
- AOD
- S/A CONTRIBUTION TO URE
- SV CLOCK PREDICT CONTRIBUTION TO URE
- PREDICTED ORBIT ERROR EFFECT ON URE
- ESTIMATED ORBIT

PRECISIONS
- S/A EFFECT
- H-MASER CLOCK ENSEMBLE STABILITY
- SV CLOCK STABILITY
- MS CLOCK & RECEIVER STABILITY
- FILTER STATE RESIDUALS

GEOMETRY
- ALMANAC / UPDATE TIMES
- CONSTELLATION CONFIGURATION
- SV-GA RISE/SET, AZ/EL
- SV-MS RISE/SET, AZ/EL
- MASTER CLOCK LOCATION

EFFICIENCY
- % SV PR ACQUIRED
- % MS WEATHER DATA ACQUIRED
- SV, GA, MS, COMM. % UP TIME
- % PR ACCEPTED
- A/W/E STATISTICS

SERVICES
- DMA: UT/PM
- USNO: GPS-UTC
- NASA: EPHEMERIDES

OPERATIONS
- # SV/FILTER PARTITION
- # PARTITIONS
- KALMAN FILTER TUNING
- FREQUENCY OF UPLOADS
- SV ORBIT/CLOCK ADJUSTS
- GPS-UTC TIME ADJUSTMENT
- MASTER CLOCK SWITCHES
- ALARMS/WARNINGS/EVENTS
- OPERATOR INTERVENTIONS

OPSCAP PERFORMANCE

(CIVILIAN EXPORTED DATA)

STATUS

GPS

NAV SERVICE EVALUATION

GLOBAL COVERAGE
S/A SETTING
3-D RMS ACCURACY (S/A)
2-D RMS ACCURACY (S/A)
DOD TIME TRANSFER ACCURACY (S/A)

STATUS

COMPONENTS: SV
NAV MSG VERIFY
CONSTELLATION FILL

PERFORMANCE

MS NAV ACCURACY
GLOBAL RMS URE

ACCURACY

AOD
S/A CONTRIBUTION TO URE
SV CLOCK PREDICT CONTRIBUTION TO URE
PREDICTED ORBIT ERROR EFFECT ON URE
ESTIMATED ORBIT

PRECISIONS

GPS TIME STABILITY
SV CLOCK STABILITY

GEOMETRY

ALMANACS
CONSTELLATION CONFIGURATION

SERVICES

DMA: UT/FM
USNO: GPS-UTC
NASA: EPHEMERIDES

OPERATIONS

MASTER CLOCK SWITCHES
TIME OF UPLOADS
SV CLOCK / ORBIT ADJUSTS
GPS-UTC TIME ADJUSTMENT

SLIDE 10

OVERVIEW OF CIVIL GPS SERVICE

DR. ARNOLD TUCKER
APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS AT AUSTIN

Applied Research Laboratories, The University of Texas at Austin (ARL:UT), has been tasked by the U.S. Air Force to examine the requirements of a Civil GPS Service (CGS). A technical steering committee was established representing the civil community to provide guidance and direct input into the establishment of the CGS. Their role is to evaluate various organizational structures to administer the CGS and provide guidance on the database to be used by the Civil GPS Information Center (CGIC). The CGS is the administration/management section of this system and the CGIC is the data acquisition and distribution section. The Department of Transportation (DOT) has assumed a major role in establishing the CGS.

The major task we have is to develop a high level system design. To achieve this, we are pursuing four tasks. First we have developed an Interface Control Document (ICD) between the Military OPSCAP and the CGIC. This document will provide the technical data to estimate storage size and computer capacity required in the CGIC. Second, we have developed a questionnaire for the civil user community which has been distributed by individuals and organizations. The goal of this effort was to determine if a need exists for a CGS and to receive inputs as to the types of data and timeliness of the data that the civil user communities require. The third task was to conduct a Civil GPS User Workshop. The purpose of this workshop was to present the ICD to a cross-section of the civil user community and revise this document based on the results from the workshop. The CGIC system design will be based on the information provided by the technical session chairmen, the results of the questionnaire, the data identified in the ICD, and the civil user inputs at the workshop. We actively solicit your inputs to us

to assist in the development of the system design. This system will be the primary GPS data source available to the civil community.

APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS AT AUSTIN

TASKED BY THE U. S. AIR FORCE
TO IDENTIFY THE REQUIREMENTS OF
THE CIVIL GPS USER COMMUNITY
AND DEVELOP A SYSTEMS SPECIFICATION
FOR THE
CIVIL GPS INFORMATION CENTER (CGIC)

SLIDE 1

CIVIL GPS SERVICE
STEERING COMMITTEE

- REVIEW POSSIBLE ADMINISTRATIVE STRUCTURES OF CIVIL GPS SERVICE (CGS)

- REVIEW PRELIMINARY SYSTEM DESIGN FOR THE CIVIL GPS INFORMATION CENTER (CGIC)

SLIDE 2

TASKING

- ASSIST IN IDENTIFYING POSSIBLE ADMINISTRATIVE AGENCIES FOR THE CIVIL GPS SERVICE (CGS)

- DEVELOP A PRELIMINARY SYSTEM DESIGN FOR THE CIVIL GPS INFORMATION CENTER (CGIC)

- IDENTIFY CATEGORIES OF CIVIL GPS USERS

- PREPARE AND DISTRIBUTE A GPS USER SURVEY TO THE CIVIL GPS USER COMMUNITY

- CONDUCT A WORKSHOP FOR CIVIL GPS USERS

- PREPARE AN INTERFACE CONTROL DOCUMENT (ICD) BETWEEN THE MASTER CONTROL STATION (MCS) AND THE CGIC

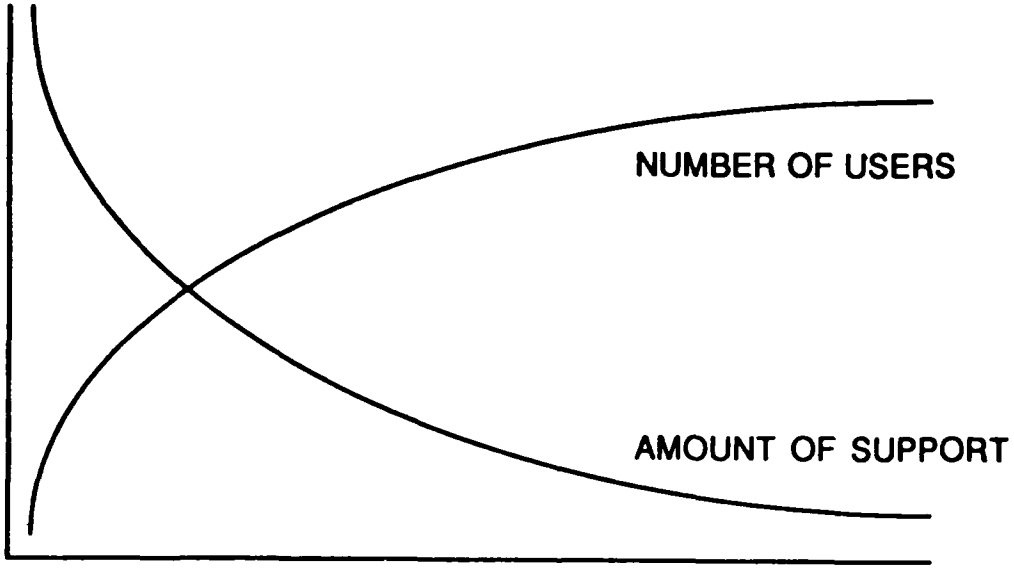
SLIDE 3

CATEGORIES OF USERS

CATEGORY	APPLICATIONS
PROFESSIONAL (GEODESY)	GEODESY
	SURVEYS
	MAPPING
	TIMING
	LEGAL
	MANUFACTURER
	TESTING
COMMERCIAL (NAVIGATION)	RAILWAYS
	TRUCKING
	SHIPPING
	AIRWAYS
RECREATIONAL	AUTOMOBILE
	SAILBOAT

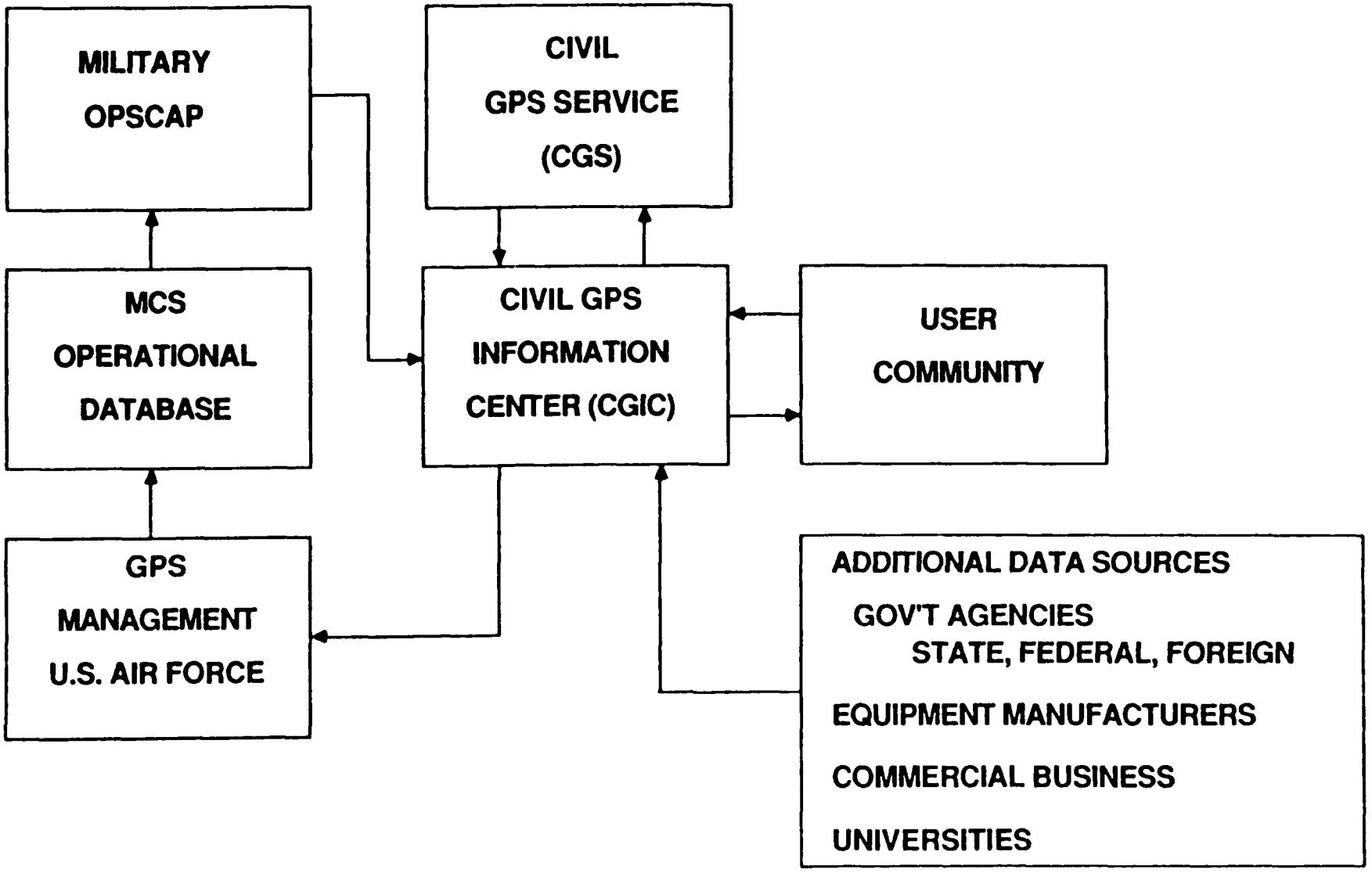
SLIDE 4

TYPES OF USERS
VS
NUMBER OF USERS AND AMOUNT OF SUPPORT



SLIDE 5

CIVIL GPS SERVICE (CGS)



SUMMARY OF DOT PLANNING

DR. RUDY KALAFUS
TRANSPORTATION SYSTEMS CENTER
U.S. DEPARTMENT OF TRANSPORTATION

Department of Transportation (DOT) has received a formal request from the Department of Defense (DoD) to assume responsibility for distribution of GPS information to civil users.

Slide 1 traces the chronology of DOT activities from receipt of DoD's request on 21 May, their response, and preparation and review of a draft program plan. The draft plan was prepared under sponsorship of DOT's Research and Special Programs Administration (RSPA) and the U.S. Coast Guard, and is currently under internal review by those agencies within DOT who will most likely be involved with administration of the plan.

Slide 2 is a block diagram of the Civil GPS Service (CGS) management structure. A Program Office would be responsible for actually running the Civil GPS Information Center (CGIC). The means of administering the CGIC, e.g., through contractual agreements, government agencies, etc., are currently under review.

Slides 3 and 4 list some of the proposed functions of the CGIC. The CGIC will process user inputs and be responsive to the different types of data requested. Making the information easily accessible to all users is an important item. It is recognized that once the CGIC is established, new users and new user services will evolve.

Currently it is conceived that the CGIC would be set up with government funds. It would be very desirable if, through user charges for various services, the CGIC could become self-supporting. The issue of funding is still being discussed and reviewed.

Slide 5 illustrates the proposed CGIC development schedule. This schedule is based on a number of premises including deployment of satellites. It is predicted that 2D operational status will be achieved by 2nd quarter fiscal '90. The availability of a provisional CGS would begin at this point in time.

Military OPSCAP projects completion of processor development by 3rd quarter fiscal '89. Until this time, no data will be available over the interface.

In response to this development schedule, DOT has proposed an interim system which would establish a DOT point of contact for civil users and immediately alleviate many of the queries currently being received by Falcon Air Force Station. The amount of information available through this interim service would obviously be a scaled down version of the information that would ultimately be available through the CGIC.

The organizational structure of DOT is shown in slide 6 and the current communication channel between DoD and DOT in regard to navigation issues is shown in slide 7.

All future communication regarding CGS should be directed to one of the following two addresses.

DOT/RSPA
ATTN DRT-1
400 7th St., S.W.
Room 8405
Washington, D.C. 20590

Commandant
USCG Headquarters
G-NRN-2
2100 2nd St. S.W.
Washington, D.C. 20593

PLANNING ACTIVITIES

- 21 MAY: LETTER WRITTEN BY DOD DEPUTY SECRETARY TAFT TO DOT DEPUTY SECRETARY BURNLEY, REQUESTING THAT DOT MANAGE THE CIVIL GPS INTERFACE & PPS SERVICE

- 29 JUNE: NAVIGATION COUNCIL APPROVES THE IDEA

- 24 AUGUST: DOT'S BURNLEY RESPONDS FAVORABLY TO DOD'S TAFT

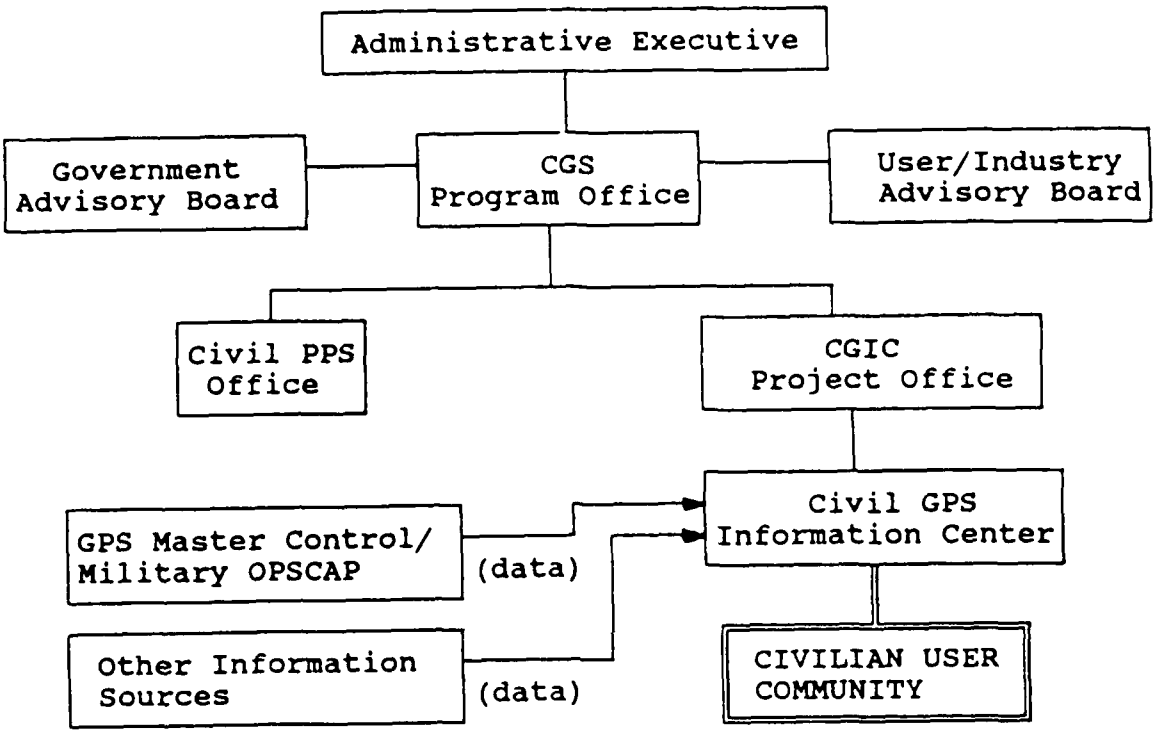
- 27 AUGUST: CIVILIAN OPSCAP COMMITTEE MEETS. IT IS DECIDED TO CALL THE INTERFACE THE "CIVIL GPS INFORMATION CENTER", OR "CGIC"; THE OVERALL CIVIL EFFORT WILL BE CALLED THE "CIVIL GPS SERVICE".

- 15 SEPTEMBER: DRAFT PROGRAM PLAN WRITTEN, REVIEWED BY RSPA AND US COAST GUARD

- 16 SEPTEMBER: NAVIGATION COUNCIL RECEIVES DRAFT OF PROGRAM PLAN FOR DOT INTERNAL REVIEW

SLIDE 1

CIVIL GPS SERVICE MANAGEMENT STRUCTURE



SLIDE 2

CIVIL GPS INFORMATION CENTER FUNCTIONS

- PROVIDE INFORMATION ON CGIC SERVICES
- PROVIDE INSTRUCTIONS ON CGIC SERVICE ACCESS
- PROVIDE BULLETIN BOARD SERVICE ON GPS STATUS, PLANNED EVENTS
- PREPARE USER-ORIENTED INFORMATION SERVICES
- MAINTAIN DATA BASES FOR COMMERCIAL/SCIENTIFIC ACCESS
- MAINTAIN RECORDS FOR LIABILITY PURPOSES
- PREPARE & DISTRIBUTE INSTRUCTIONAL MATERIALS
- ANSWER QUESTIONS, BY TELEPHONE & CORRESPONDENCE
- DISTRIBUTE PERIODIC SUMMARY REPORTS
- NOTIFY USERS OF SIGNIFICANT EVENTS (TELEX, ELECTRONIC MAILBOX)
- DEVELOP NEW USER SERVICES
- MAINTAIN & AUGMENT COMPUTER/COMMUNICATIONS EQUIPMENT

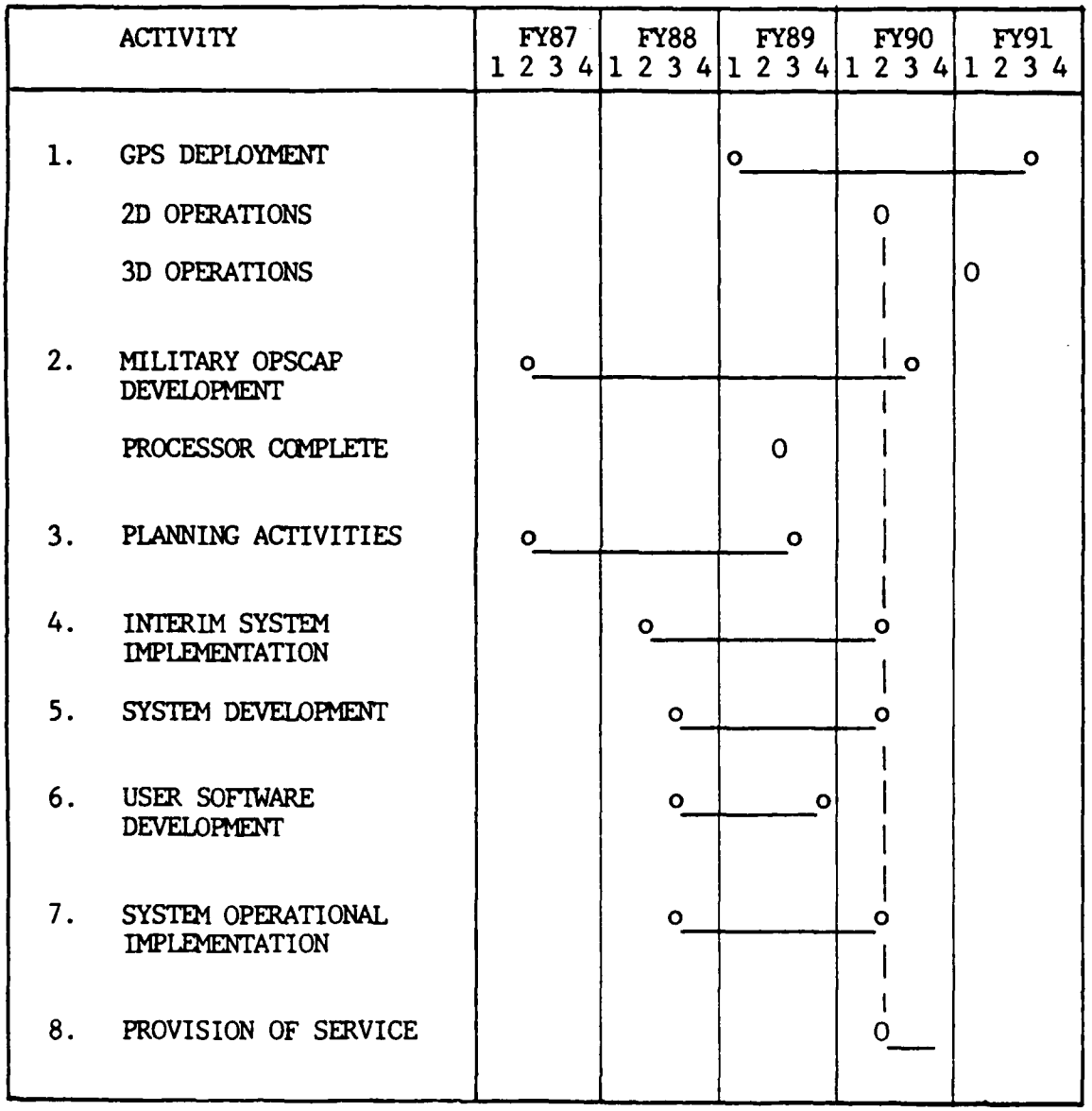
SLIDE 3

CIVIL PPS OFFICE FUNCTIONS

- MANAGE PPS PROGRAM
- PROVIDE INFORMATION ON AVAILABILITY & COST OF SERVICE
- PROCESS APPLICATION FORMS
- DETERMINE FEES
- SCREEN APPLICANTS FOR VALID NEED FOR SERVICE
- COORDINATE WITH DOD ON SECURITY CLEARANCES & SERVICE GUIDELINES
- EVALUATE FACILITIES & SECURITY OF APPLICANTS
- COLLECT SERVICE FEES
- PROVIDE PPS SERVICE TO AUTHORIZED USER
- MAINTAIN RECORDS ON SERVICE
- RECOMMEND IMPROVEMENTS IN SERVICE

SLIDE 4

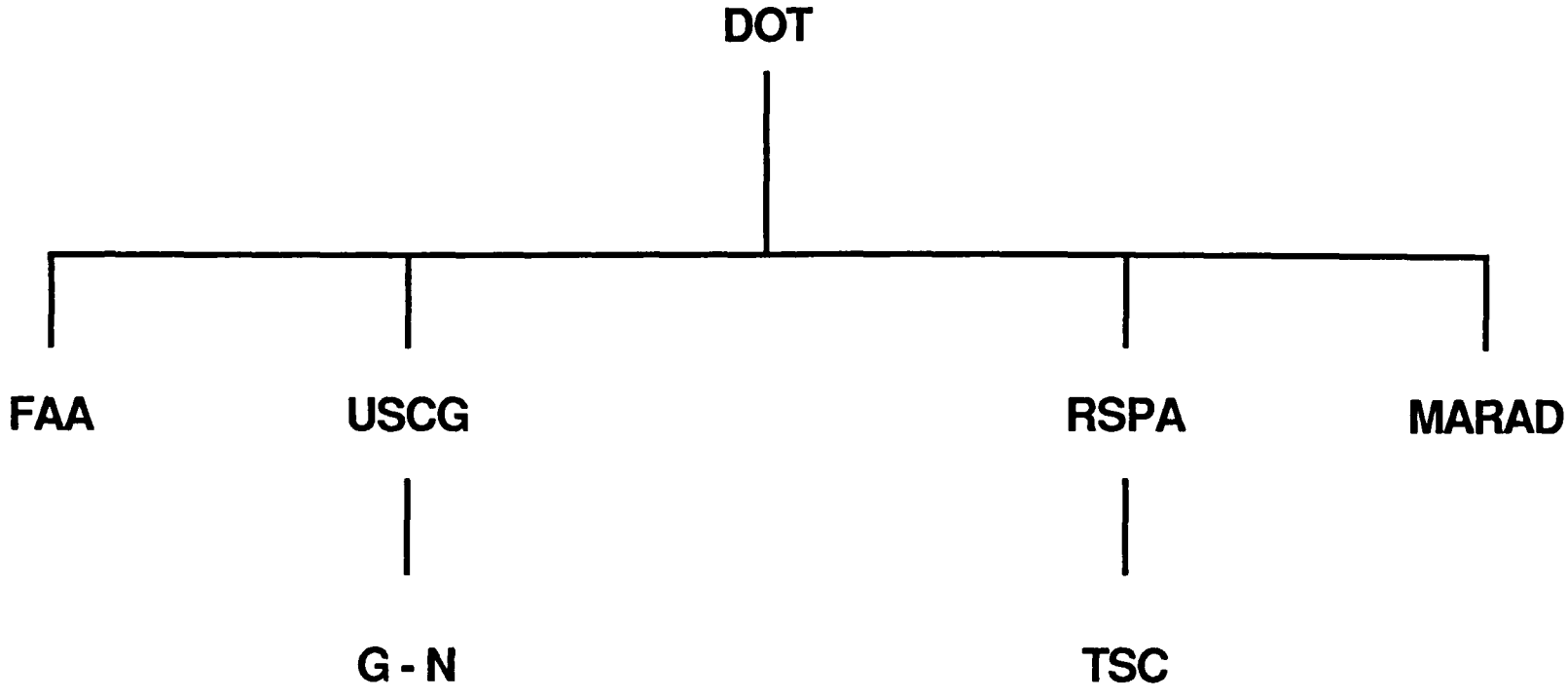
CIVIL GPS INFORMATION CENTER DEVELOPMENT SCHEDULE



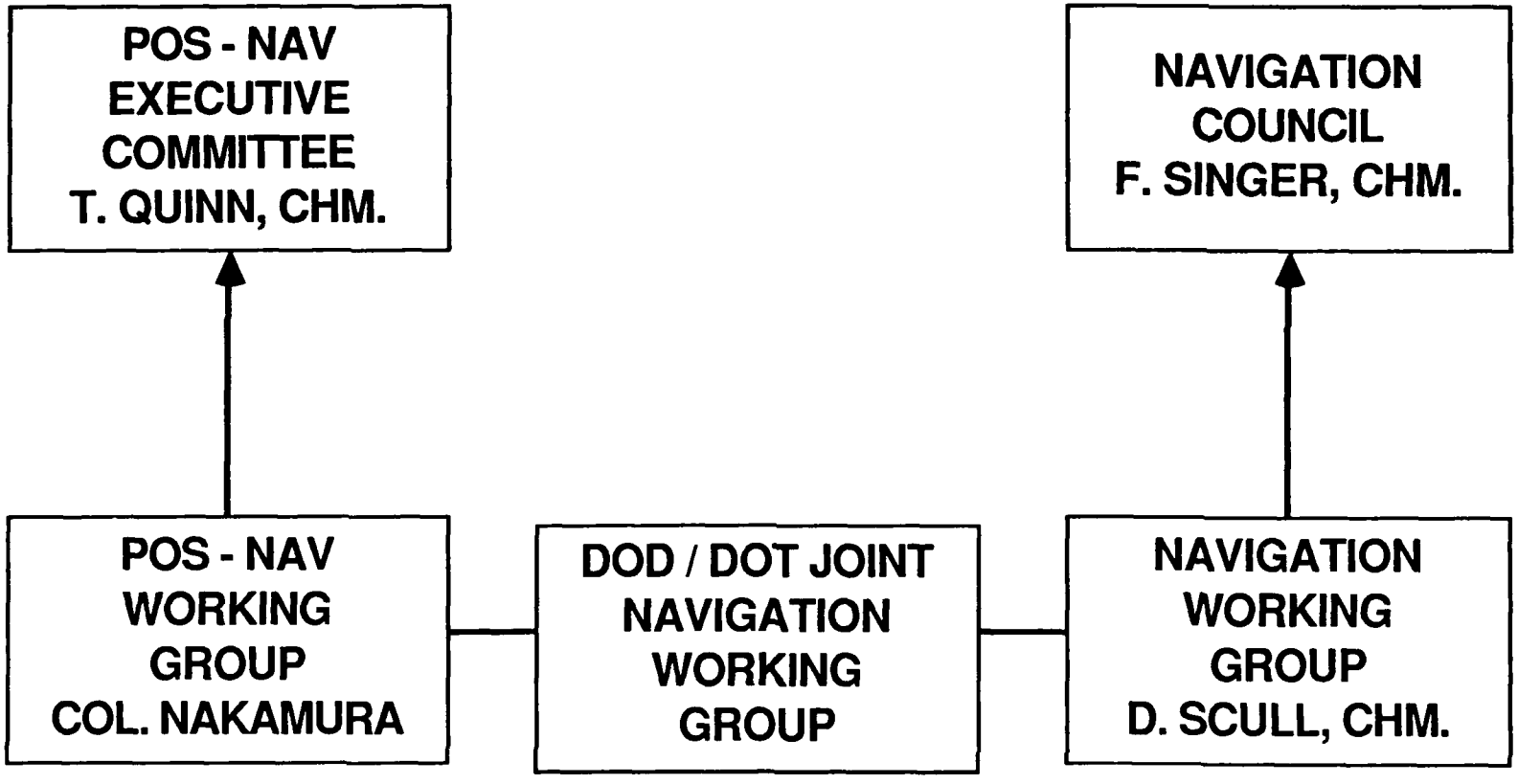
SLIDE 5

DOT ORGANIZATIONAL STRUCTURE

SEC.	J. BURNLEY
DEPUTY SEC.	M. DAWSON
CHIEF SCIENTIST	F. SINGER



DOT / DOD NAVIGATION STRUCTURES



CIVIL GPS USER SURVEY RESULTS

MR. BRENT RENFRO
APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS AT AUSTIN

As part of the effort undertaken to define the Civil GPS System (CGS), Applied Research Laboratories, The University of Texas at Austin (ARL:UT), has developed a survey to assess the level of interest in the CGS and to aid in the determination of the user requirments, slide 1. This effort was complicated by several factors including the following:

1) only professional users of GPS are knowledgeable of GPS at this time,
2) anticipated response to most surveys is less than 5%, and
3) direct mailing of survey was not feasible due to government regulations.

The latter problem was somewhat reduced when The Institute of Navigation (ION) volunteered to distribute the survey in the announcement of the meeting of the Satellite Division of the ION, slide 2. While this mailing reached approximately 10,000 persons, it is difficult to determine how many actually found the survey. In addition to the distribution by the ION, the survey was made available on the computer bulletin boards maintained at the United States Naval Observatory (USNO) and the Yuma Proving Grounds. Both of these bulletin boards contain GPS information which is accessed by a wide variety of users. The response to date includes 83 surveys. Of these, over half are of foreign origin.

Slides 3-5 show the response to selected questions from the CGS survey.

Slides 6 and 7 summarizes the results (to date) of the CGS survey. The application which interested the greatest number of users was geodetic applications, followed by commercial marine navigation, and

timekeeping. In terms of data types, the strongest interest was in satellite status information.

The survey is still being provided to interested parties and returned surveys are still being processed. An effort is also underway to discuss the CGS with various organizations to determine if they are interested in supporting the survey effort.

It is felt that the current survey response is inadequate to serve as an indicator of the strength of the requirement for a CGS or as a reliable guide to the data types users would desire. The small domestic response and the strong bias of the results toward the professional community are prime reasons for this opinion. It is hoped that sufficient responses will be forthcoming to allow for opinion to be revised.

RESULTS OF CGS SURVEY

PURPOSE OF CGS SURVEY

- TO DETERMINE LEVEL OF INTEREST IN CGS CONCEPT

- TO AID DESIGN OF CGS BY PROFILING POTENTIAL USERS

DIFFICULTIES

- ONLY "PROFESSIONAL" USERS ARE KNOWLEDGEABLE OF GPS AT THIS TIME

- ANTICIPATED RESPONSE LESS THAN 5%

- DIRECT MAILING NOT FEASIBLE DUE TO GOVERNMENT REGULATIONS

SLIDE 1

RESULTS OF CGS SURVEY

DISTRIBUTION

- INCLUDED IN ION ANNOUNCEMENT (ABOUT 10,000)

- AVAILABLE ON USNO BULLETIN BOARD

- AVAILABLE ON YUMA BULLETIN BOARD

RESPONSE (TO DATE)

- DOMESTIC	36
- FOREIGN	47
TOTAL	83

SLIDE 2

GPS CIVIL USER SURVEY

1. With which application(s) of GPS will you be involved?

51	Navigation	26	Time/Frequency
45	Surveying	13	Manufacturer
46	Position Location	4	Other

2. What best characterizes the type of user you are?

AVIATION/AEROSPACE

12 General Aviation
7 Commercial Aviation, Air Taxi, Helicopter, etc.
6 Aerospace

MARINE

5 Recreational Boater
4 Fisherman
29 Commercial Shipping, Passenger Vessels

LAND

5 Trucking/Railroads
8 Automobile/Bus Fleets (Police, Taxi, etc.)
4 Public Safety (EMS, Firefighting Vehicles, etc.)
39 Geodetic Survey
2 Legal/Record Keeping
21 Timekeeping

OTHER 9

3. Your requirements for assistance or for data will fall into what categories?

40 Basic Planning on GPS (e.g., System Overview)
54 Planning Information (e.g., Projected Performance)
71 Status Information
35 Archival Data (e.g., Performance History)

SLIDE 3

4. What method(s) will you use to obtain information on GPS?

35 Direct Contact	18 Data Tapes or Disks
12 Voice Recording	54 Publications
55 Computer Access via Modem	19 NOTAMS and/or Notices to Mariners

5. What is your current level of experience with GPS?

- 11 No Experience
- 24 Informed about GPS (Publications, Meetings)
- 62 Operational Experience (Receiver Operation/ Data Processing)

12. What methods of application will you use?

55 Point Positioning	38 Differential Positioning
45 Relative Positioning	27 Time Transfer

13. Which type(s) of information will you require?

- 43 Timing
- 70 Satellite Operational Status
- 50 Orbit
- 53 Scheduled Events (e.g., Satellite Launches)
- 6 Other

SLIDE 4

14. List the specific kinds of information needed to meet your requirements.

TIMING

28 GPS Time Steer Schedule
43 GPS-UTC Phase & Frequency Offset
1 Other(s)

SATELLITE OPERATIONAL STATUS

66 SV Health
45 SV Upload Schedule
3 Other(s)

ORBIT

50 SV Almanac
40 SV Orbit Adjust
4 Other(s)

17. What is your anticipated location at the time you will require assistance from the Civil GPS Service?

6 Africa
2 Antarctica
8 Arctic
11 Asia
10 Australia
37 Europe
36 North & Central America
7 South America
10 Atlantic Ocean
6 Indian Ocean
11 Pacific Ocean
5 Global

SLIDE 5

RESULTS OF CGS SURVEY

SURPRISINGLY STRONG FOREIGN RESPONSE

CURRENT RESPONSE INADEQUATE

- INSUFFICIENT DOMESTIC INTEREST TO SUPPORT STRONG REQUIREMENT

- RESULTS STRONGLY BIASED TOWARD PROFESSIONAL COMMUNITY

SLIDE 6

RESULTS OF CGS SURVEY

CURRENT RESULTS INDICATE

STRONGEST INTEREST (APPLICATION) IN GEODETIC SURVEY, COMMERCIAL MARINE NAVIGATION, TIMEKEEPING

STRONGEST INTEREST (DATA TYPE) IS CURRENT SV STATUS INFORMATION

FURTHER EFFORT IN PROGRESS

CONTINUING TO PROVIDE/ACCEPT/PROCESS SURVEYS

DISCUSSING CGS WITH RELEVANT ORGANIZATIONS

SLIDE 7

INTERFACE CONTROL DOCUMENT

MR. PATRICK PASTOR
APPLIED RESEARCH LABORATORIES
THE UNIVERSITY OF TEXAS AT AUSTIN

From the perspective of the GPS Civil user community, the Civil GPS Service Interface Control Document (CGS-ICD) summarizes the information in the Master Control Station (MCS) and Military OPSCAP database that is of interest to civil users. More formally, the CGS-ICD is a technical document describing the interface between the Military OPSCAP and the CGS; it is similar to the GPS-ICD-200 with which many users may be familiar. This presentation, slide 1, is a primer on the CGS-ICD presented to prospective end users of the Civil GPS Information Center (CGIC).

Due to the complexity of the subject, an outline (slide 2), gives an overview of the items to be discussed.

The interface addressed by the CGS-ICD is defined from three different perspectives, (slides 3 through 5). The interface that is described by the CGS-ICD concerns the flow of data from the Military OPSCAP system to the CGIC. The CGS management structure, slide 3, illustrates that not all data being input to the CGS will come from the GPS Master Control/Military OPSCAP source. These other data inputs will be described by future ICDs. The OPSCAP architecture, slide 5, indicates that the Military OPSCAP gathers data from the MCS system database and, in addition to using that information to support analysis, also outputs pre-defined data subsets to user-specific data sets. The CGIC is only one of several user data set nodes. The CGS-ICD defines the pre-defined data flow between the Military OPSCAP and the CGIC.

The participants involved in the design of the ICD-CGS are discussed in slide 6. Applied Research Laboratories, The University of Texas at

Austin (ARL:UT), is conducting a study of the requirements for a Civil GPS Service. ARL:UT receives guidance from the CGS Steering committee which meets quarterly. In the course of the CGS-ICD's development, several meetings have been held with IBM personnel who are responsible for developing the Military OPSCAP system. These ARL:UT/IBM meetings have determined that the data items described in the current draft CGS-ICD are technically available from the MCS database. The United States Air Force/Space Command which is funding the current phase of the CGS study is reviewing the content of the current ICD draft.

The next vugraph, slide 7, presents the organization of the ICD document. Section 1.0 through 3.0 are self-explanatory. Beginning in Section 4.0, the proposed CGS data is described in two ways. Section 4.1 categorizes the data according to its information content. Section 4.2 discusses when that information is transferred to the CGIC. The information content and transfer types introduced here will be discussed in greater detail later. The range of the communications from the Military OPSCAP to the CGIC is discussed in Section 5.0. Section 6.0 presents the conventions for specifying time tags, SVs, etc. Lastly, the Appendices present the data transfer blocks themselves, arranged according to when they are transferred to the CGIC.

The constraints that dictated the design of the CGS-ICD are summarized in slide 8. The first two constraints are driven by user requirements. The distinction between update and transfer rate can be illustrated by describing these characteristics as they affect the availability of post-fit ephemerides. The current CGS-ICD proposes that Kalman estimated post-fit ephemerides be made available after a long delay. The transfer rate is therefore the long delay period. However, the CGS-ICD also proposes that these same ephemerides be updated every hour. So, in summary, the transfer rate is the delay between a datum's creation and its availability to the user; the update rate is the sample rate at which successive data items will be transferred.

The last three constraints act as a counterbalance to the constraints driven by user requirements. The last two in particular deal with minimizing the complexity of the CGIC. They exist in order to minimize the burden on the Military OPSCAP/CGIC communication link, and the CGIC processors. In general the transfer blocks have been designed so as to minimize the amount of reformatting/rescaling required internal to the CGIC system.

A model that resolves the competing constraints is to have multiple transfer types. The three proposed transfer types are presented in the next vugraph, slide 9. The transfer delay times can only be estimated at the current time; they will be determined in part by user requirements. As currently proposed, near realtime transfer data will contain general advisory information that is available shortly after its creation in the MCS/Military OPSCAP. This category contains generalized status and scheduled/predictive information. All broadcast NAV message information will be available after a short delay. Included with items to be transferred to the CGS after a long delay are proposed quantities that a user would be interested in to perform post-anomaly detection and correction. This category is not intended to provide realtime integrity information.

The next vugraph, slide 10, illustrates how the different information categories map into the three proposed data transfer categories.

"Near Realtime" information (slide 11) includes two different types of "Advisories": (1) future or scheduled/predictive events and (2) current or unscheduled/unforeseen events as recognized by the MCS or Military OPSCAP. Each of the two advisories are, in turn, broken up into two sub-categories. The first is referred to as "Notifications". Notifications are the proposed successor to the NANUs, the NAVSTAR Notice to Users. The Notifications should not be confused with the NOTAMS,

which are separate. The Notifications, like the current NANUs, are to be human generated, though using a pre-defined format so that their contents would be amenable to a database search.

The second sub-category of Notifications are Alarm/Warning/Event Status messages, referred to as A/W/Es. A/W/Es are currently generated internal to the MCS, they contain system generated status information. The CGS-ICD proposes that a very small subset of the A/W/Es, those that are of interest to the civil user, be allowed to pass through to the CGIC. Those A/W/Es containing only quantitative information would be available in the Near Realtime transfer category; other A/W/Es, those containing more sensitive information, would be transferred after a long delay via the Post Facto transfer category.

The next transfer category is "Short Delay" information, slide 12. As discussed earlier, the Short Delay category is proposed to serve as an alternate source of the NAV message information. This alternate source NAV information would be global, spanning all SVs over all GPS times. The Short Delay transfer category would keep a record of all NAV messages that can be seen by a GPS receiver located anywhere on the earth. To lessen requirements for processing internal to the CGIC, it is proposed that the Short Delay's NAV message information be transmitted in both the broadcast format and engineering units. Therefore, two formats would exist for each NAV message transmitted to the CGIC, except for Reserve Pages which would only be transmitted in the broadcast format.

The third and last transfer category is termed "Post Facto" information, slide 13. The Post Facto information will not be available until a to-be-determined long delay has transpired since the information's time tag of applicability. The Post Facto information is proposed to contain performance, ephemeris, GPS clock, ionospheric, and Military OPSCAP information of interest to civil users. SV/MCS/MC/MS Operational Status Changes include that class of A/W/Es generated

internal to the MCS or Military OPSCAP that for security considerations will be delayed. A detailed discussion of each of the constituents of the Post Facto information category is contained under Section 4.1 and Appendix C of the draft CGS-ICD.

Having discussed the information to be made available and when it is to be transferred to the users, it is possible to address the sizing of the CGIC system's daily information throughput. The assumptions that have been made to estimate the CGIC sizing are presented in slide 14. The first assumption is a full 21-SV constellation. The next assumption is that the MCS will generally adhere to their current NAV message update practices. It is also assumed the alternate source NAV message information is complete over all SVs and over all pages. Lastly, it is assumed in the Post Facto information category, information that is derived from the Kalman update cycle will be sampled every hour.

Using these assumptions, the following sizing estimates can be made, slide 15. It should be noted that the previous assumptions can be tuned to provide a range of sizing estimates. The selected assumptions estimate the system throughput at almost 1 Mbyte of information per day. The draft CGS-ICD proposes that this volume be tunable so that the system can accommodate other constraints whether they be imposed by system usage, the communication link, or system resources of the CGIC or the Military OPSCAP.

Those users who will obtain a CGS-ICD will see that it contains a great deal of detail regarding data sizing, transfer priorities, system tuning, and communication conventions. However, from the perspective of this workshop the most important consideration is to what extent the CGS-ICD, as currently proposed, meets the civil GPS user's requirements for data available from a CGIC. To help in answering this fundamental question, we propose three questions for prospective CGIC users' consideration, slide 16. The first question asks if any information that

a user requires is missing from the current CGS-ICD draft. The second asks if the proposed transfer categories make the different types of data available in a fashion that meets user requirements. The last question asks if data from the MCS Kalman filter update cycle are sampled frequently enough.

PRESENTATION

OF

MILITARY OPSCAP/

CIVIL GPS SERVICE

INTERFACE CONTROL DOCUMENT

AT

GPS CIVIL USER WORKSHOP

22 SEPTEMBER 1987

COLORADO SPRINGS

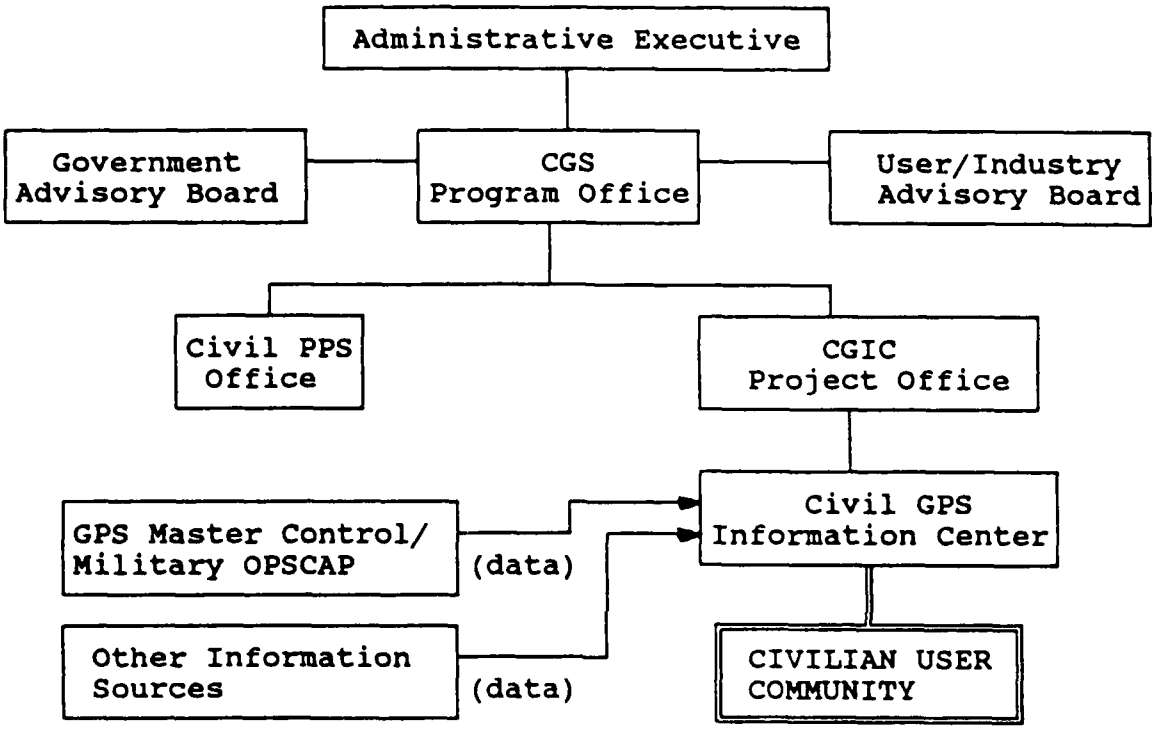
SLIDE 1

OUTLINE

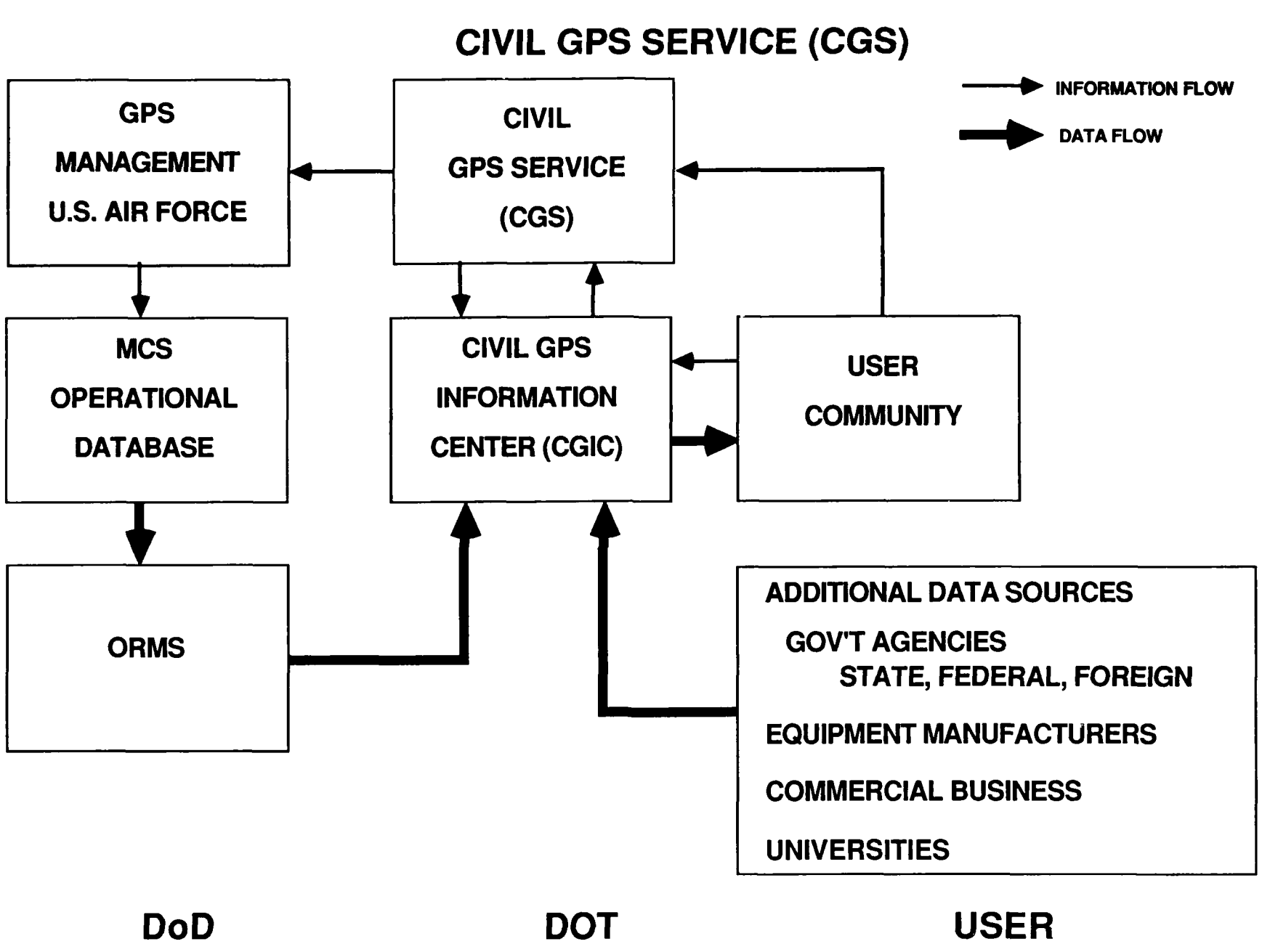
- IDENTIFICATION OF INTERFACE
- DESIGN PARTICIPANTS
- ORGANIZATION OF THE INTERFACE CONTROL DOCUMENT
- CONSTRAINTS AFFECTING THE MILITARY OPSCAP / CIVIL GPS SERVICE INTERFACE
- PROPOSED DATA INFORMATION CONTENT AND TRANSFER REQUIREMENTS
- DATA VOLUME AND SYSTEM IMPLICATIONS
- QUESTIONS FOR CONSIDERATION

SLIDE 2

CIVIL GPS SERVICE MANAGEMENT STRUCTURE



SLIDE 3



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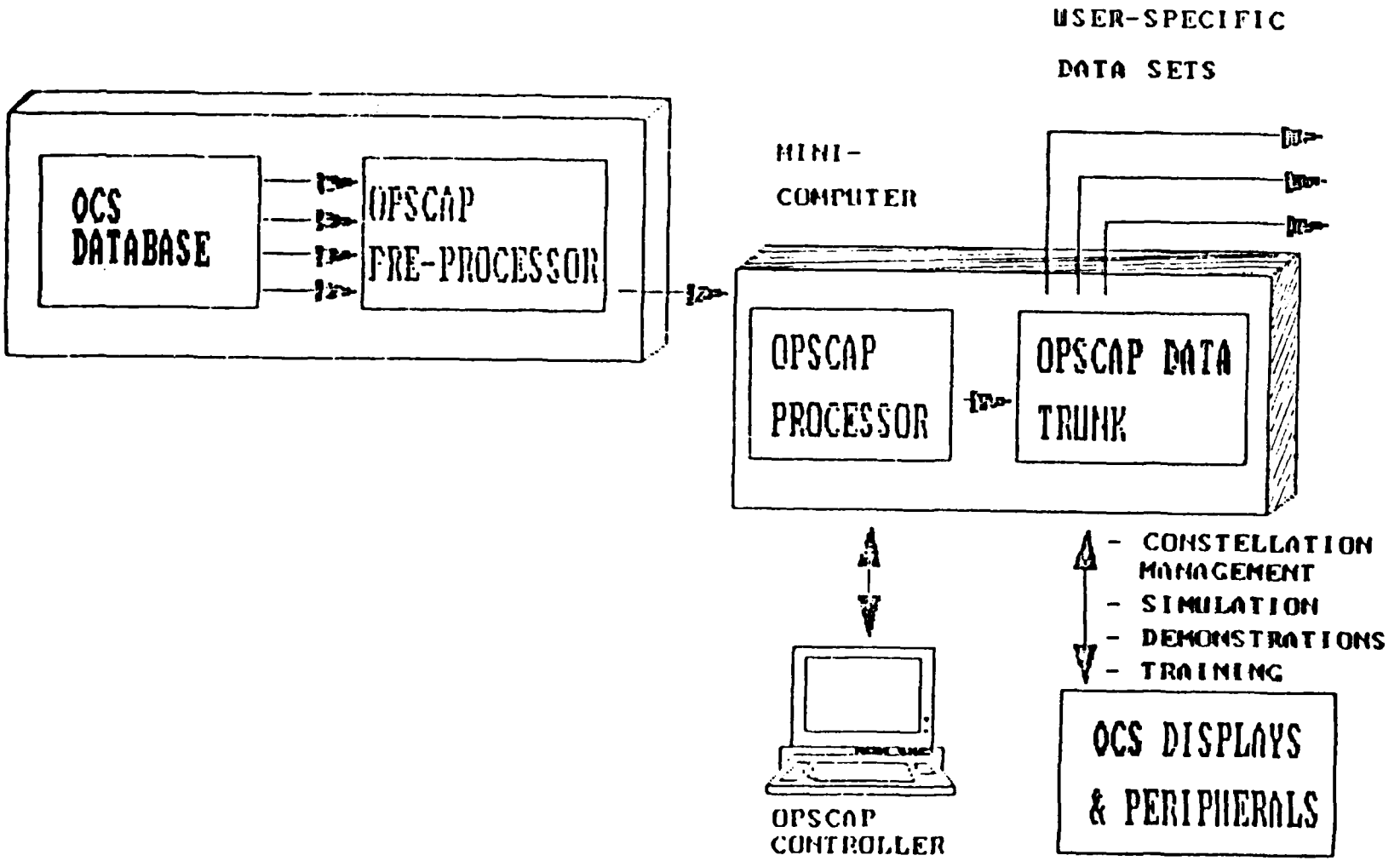
SLIDE 4

FIGURE 1

CGS ORGANIZATIONAL DIAGRAM

OPSCAP ARCHITECTURE



PARTICIPANTS

ARL:UT	CONDUCTING THE STUDY
CGS STEERING COMMITTEE	GUIDANCE
IBM	DETERMINATION OF AVAILABILITY AND IMPACT ON MCS
USAF/SC	HAS CURRENT ICD DRAFT.

SLIDE 6

ICD ORGANIZATION

1.0 SCOPE

2.0 APPLICABLE DOCUMENTS

3.0 CIVIL GPS SERVICE OVERVIEW

4.0 CIVIL GPS SERVICE DATA QUANTITIES

- 4.1 CATEGORIZATION OF DATA BY INFORMATION TYPE

  4.1.1 - 4.1.8

- 4.2 CATEGORIES OF DATA TRANSFER REQUIREMENTS
  - 4.2.1 NEAR REALTIME INFORMATION
  - 4.2.2 SHORT DELAY INFORMATION
  - 4.2.3 POST FACTO INFORMATION

5.0 COMMUNICATIONS BETWEEN MILITARY OPSCAP AND CIVIL GPS INFORMATION CENTER SYSTEMS

5.1 - 5.4

6.0 COMMON ELEMENT DEFINITIONS

10.0 APPENDIX A: NEAR REALTIME TRANSFER BLOCKS

20.0 APPENDIX B: SHORT DELAY TRANSFER BLOCKS

30.0 APPENDIX C: POST FACTO TRANSFER BLOCKS

40.0 APPENDIX D: NON-REGULAR TRANSMISSION BLOCKS

COMPETING CONSTRAINTS

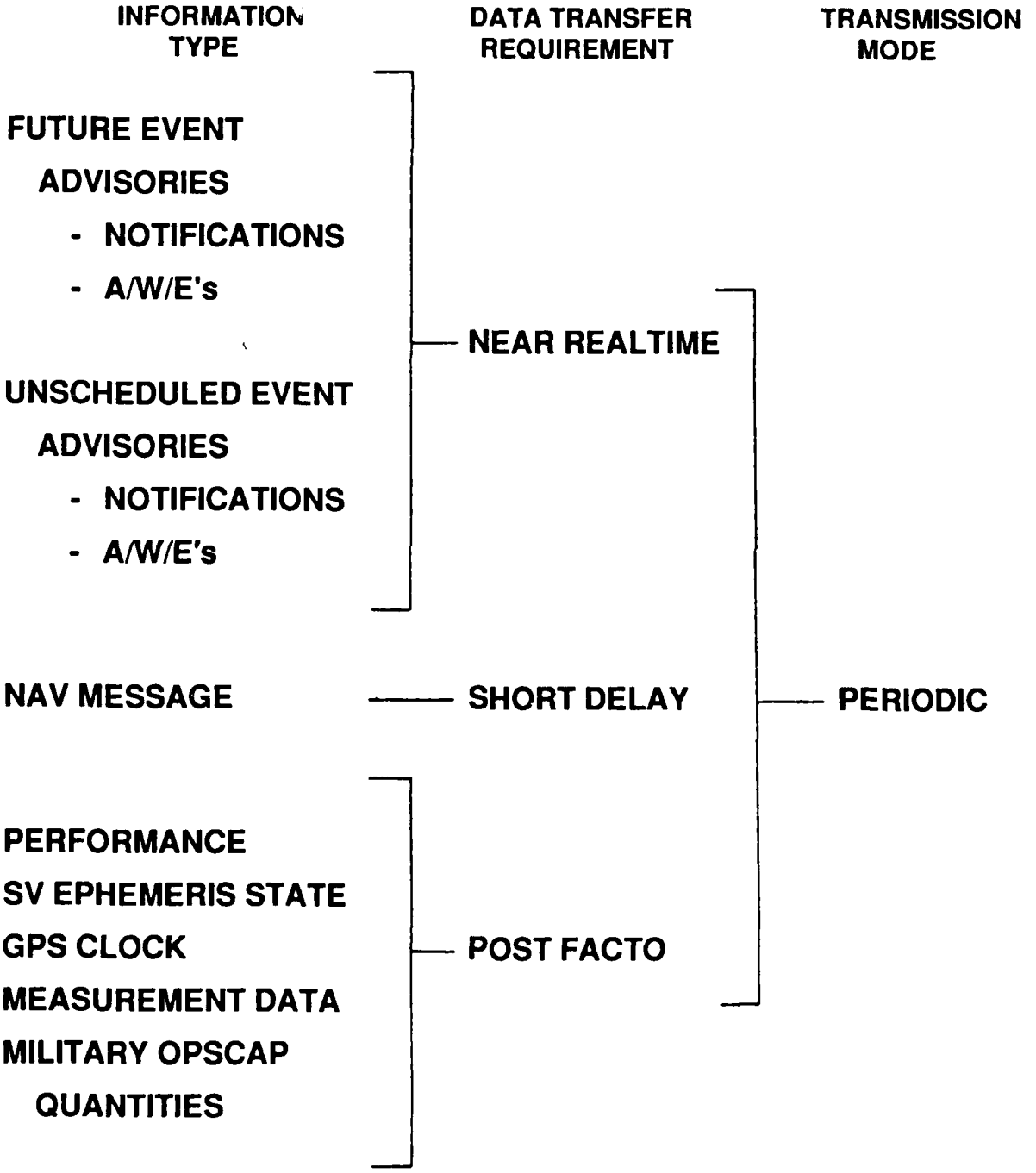
- SUFFICIENT INFORMATION TO MEET USER REQUIREMENTS
- INFORMATION UPDATED AT AN APPROPRIATE RATE AND TRANSFERRED IN A TIMELY FASHION
- SECURITY CONSIDERATIONS
- MANAGEABLE COMMUNICATION LINK THROUGHPUT
- MINIMIZE CIVIL GPS SERVICE PROCESSING BURDENS

SLIDE 8

DATA TRANSFER TYPES

- NEAR REALTIME
  - SYSTEM TESTING AND STATUS AVAILABLE IN NEAR REALTIME
- SHORT DELAY
  - ALTERNATE SOURCE OF NAV MESSAGE INFORMATION AVAILABLE AFTER SHORT DELAY (MINUTES)
- POST FACTO
  - MCS POST DETERMINED QUANTITIES AND MCS FILTER QUANTITIES AVAILABLE AFTER A LONG DELAY (DAYS)

COMPOSITE PICTURE



SLIDE 10

"NEAR REALTIME" INFORMATION

FUTURE EVENT ADVISORIES

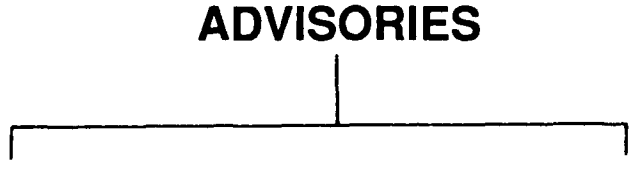
NOTIFICATIONS AND A/W/E's

SCHEDULED EVENTS

UNSCHEDULED EVENT ADVISORIES

NOTIFICATIONS AND A/W/E's

UNSCHEDULED, UNFORESEEN EVENTS



NOTIFICATIONS (HUMAN GENERATED)

ALARM/WARNING/EVENTS (SYSTEM GENERATED)

SLIDE 11

"SHORT DELAY" INFORMATION

ALTERNATE SOURCE OF NAV MESSAGES

- ALMANAC
- BROADCAST EPHEMERIS
- IONOSPHERIC AND UTC DATA
- SPECIAL MESSAGE
- HEALTH AND A/S CONFIGURATION
- RESERVED PAGE TYPE 1
- RESERVED PAGE TYPE 2
- SPARE PAGES

(IN BOTH BROADCAST AND ENGINEERING UNITS - EXCEPT RESERVED)

"POST FACTO" INFORMATION

PERFORMANCE INFORMATION

- SV MONITORED HEALTH
- SV-MS ORDs AND ERDs
- SV URA's VERSUS ABSOLUTE TIME
- SV/MCS/MC/MS OPERATIONAL STATUS CHANGES
- GLOBAL SV TRANSMIT AND UPLOAD SCHEDULE

EPHEMERIS INFORMATION

- KALMAN ESTIMATED SV STATES
  - POSITIONS, VELOCITIES, CLOCK, COVARIANCE MATRIX

GPS CLOCK INFORMATION

- SV/MC TIME STEER PARAMETERS
- SV/MS CLOCK ADJUSTMENT PARAMETERS
- SV/MS CLOCK CALIBRATION
- GPS-UTC COORDINATION

MEASUREMENT DATA INFORMATION

- OCS IONOSPHERIC DATA

MILITARY OPSCAP INFORMATION

- GLOBAL DOP QUANTITIES

ASSUMPTIONS REGARDING DATA VOLUME

- 21 SV CONSTELLATION
- CURRENT MCS UPDATE PRACTICES
- ALTERNATE SOURCE NAV MESSAGE INFORMATION
  - COMPLETE OVER ALL SVs AND ALL PAGES IN BOTH BROADCAST AND ENGINEERING UNITS (EXCEPT RESERVED)
- POST FACTO INFORMATION
  - COMPLETE OVER ALL SVs
  - KALMAN QUANTITIES AVAILABLE EVERY HOUR (TUNABLE)
  - IONOSPHERIC DATA EVERY 15 MINUTES (TUNABLE)

CIVIL GPS SERVICE DATA VOLUME

		TUNABLE RANGE Kbytes/DAY	INTERMEDIATE ESTIMATE Kbytes/DAY
I	NEAR REALTIME	N/A	9
	FUTURE AND UNSCHEDULED EVENT ADVISORIES		
II	SHORT DELAY	N/A	420
	NAV MESSAGE ALTERNATE SOURCE		
III	POST FACTO		
	PERFORMANCE	57 - 196	91
	KALMAN ESTIMATED SV EPHEMERIS	2 - 184	46
	COVARIANCE MATRIX	11 - 1040	260
	GPS CLOCK	33 - 393	120
	SUBTOTALS	103 - 1813	517
IV	MEASUREMENT DATA		
	OCS IONOSPHERIC DATA	0 - 420	28
	TOTALS	532 - 2662	974

QUESTIONS
FOR CONSIDERATION

- ANY INFORMATION MISSING?
- IS INFORMATION AVAILABLE TO USER WHEN NEEDED AND IN A TIMELY FASHION?
- IS INFORMATION UPDATED FREQUENTLY ENOUGH?

SLIDE 16

III. TECHNICAL DISCUSSION GROUPS SUMMARIES

Summaries for each of the five technical discussion groups follow. Preceding each summary is a brief abstract and a slide identifying the civil user group being addressed in each of the technical discussions.

GUIDELINES FOR DISCUSSION GROUP

ICD DEVELOPED FROM THE MCS DATABASE.

DOES INFORMATION CONTENT, AGE OF DATA, AND FREQUENCY OF UPDATE MEET YOUR REQUIREMENTS?

IDENTIFY APPLICATIONS REQUIRING DATA REQUESTED.

TIMING / FREQUENCY / COMMUNICATIONS

GENERAL APPLICATIONS:

- TIME / FREQUENCY

TYPES OF USERS:

- TIMEKEEPING
- TIME TRANSFER
- COMMUNICATION USERS INTERESTED IN FREQUENCY STABILITY

METHODS OF SOLUTION:

- TIME TRANSFER

SPECIFIC APPLICATIONS:

- COMMON VIEW TIME TRANSFER
- TIME DIVISION MULTIPLE ACCESS (TDMA)

TIMING/FREQUENCY/COMMUNICATIONS DISCUSSION GROUP

DISCUSSION TOPICS

This session is oriented to the discussion of GPS as used by the time and frequency community. This discussion addresses those operating time transfer receivers, and communication users interested in frequency stability, time transfer, and Time Division Multiple Access (TDMA) applications. The discussion will first determine the types of data of interest to the timing and frequency community and then will consider the availability and format of these data as described in the Interface Control Document (ICD) for the Civil GPS Service (CGS). The session will also discuss Selective Availability and interest in undegraded signals as it addresses the timing and frequency community. Corrections applied to scheduling and timing applications will be discussed as well as synchronization requirements for TDMA communication systems.

TECHNICAL DISCUSSION SUMMARY
TIMING/FREQUENCY/COMMUNICATIONS

CO-CHAIRMEN
MR. DAVID ALLAN, NATIONAL BUREAU OF STANDARDS
DR. WILLIAM KLEPCZYNSKI, U.S. NAVAL OBSERVATORY

There are four needs seen within the Time/Frequency civilian community. The most important is minimal selective availability impact. In terms of the future, we would like to recommend civil access to at least one undegraded satellite to avoid the impact of selective availability on the Time/Frequency community. In conjunction with that, it would be extremely important to the Time/Frequency community if selective availability could be made available in an orderly, released fashion; coordinated with DoD so as not to impact security. In other words, if post ephemeris could be made available in a timely fashion (delay of about two days) that would be of great benefit.

The second need that came up in our discussion group was traceability. Within industry there is a requirement to have NBS traceability. Because GPS is a military system under DoD directive, it is USNO traceable. This may appear to be a fine point, but legally industry has an NBS traceability responsibility and in serving the civil community, this legal requirement for NBS traceability must be recognized. On a larger scale, there are those who want traceability to international atomic time -- to UTC or TAI. We recommend that the data available from the CGS database also be traceable to TAI and NBS so the civil user requirements may be met.

Thirdly, a need for a large database to handle both general and specific information was identified. More frequent updates to this database would also be desirable. Also, by including future planning information in the database, it would serve a useful purpose in management planning activities. We recommend that this database allow

for high user interaction so that it is capable of growing and adapting with time as user needs evolve with the system.

Finally, we saw a need to have coordination between DOT, acting as the central focus agency for DoD, and other agencies such as the International Bureau of Weights and Measures (BIPM), NOAA, NGS, and NDS

SURVEYING / GEOPHYSICS

GENERAL APPLICATIONS:

- SURVEYING
- POSITION LOCATION

TYPES OF USERS:

- GEODESISTS
- GEOPHYSICISTS
- ATMOSPHERIC SCIENTISTS
- OTHER SCIENTIFIC USERS

METHODS OF SOLUTION:

- POINT POSITIONING
- RELATIVE POSITIONING (POST)

SPECIFIC APPLICATIONS:

- NETWORK SURVEYING / CONTROL POINTS
- GEOID/GEOPOTENTIAL MAPPING
- CRUSTAL DYNAMICS
- ATMOSPHERIC PHENOMENON

SURVEYING/GEOPHYSICS
DISCUSSION GROUP

DISCUSSION TOPICS

The session will be for those users who intend to use GPS to meet positioning requirements for geodetic, geophysical, and other scientific applications. The discussion will focus on the support which the Civil GPS Service (CGS) should provide to meet planning, operational, and postprocessing data requirements. The positioning methods covered will range from code tracking receivers for point positioning to code/codeless receivers making carrier phase measurements for precise static and kinematic relative positioning.

A synopsis of the Interface Control Document (ICD) for CGS will be presented and discussed with emphasis on the control segment data and security constraints associated with these data. The attendees will be invited to provide a brief description of their specific applications and their concerns.

TECHNICAL DISCUSSION SUMMARY
SURVEYING/GEOPHYSICS

CO-CHAIRMEN
MR. LARRY HOTHEM, NATIONAL GEODETIC SURVEY
MR. MIKE ELLETT, JOINT PROGRAM OFFICE

(1) General: The session was held in the Stratton Room of the Antler's Hotel. The session opened at 11:00 AM and adjourned at about 12:40 PM.

On the average, approximately 25 persons were in attendance -- at times there were over 30. Since the form "Proposed applications of GPS and specific areas of interest" was distributed to all attendees, a separate attendance list was not gathered. Twelve forms with names, addresses, and comments were submitted. Some of the others attending the session were also present at other sessions and submitted the form to the chairman at that session.

Twenty-eight copies of the proposed Interface Control Document (ICD) were distributed. Attendees were solicited to review the ICD and respond to ARL:UT by 31 October 1987.

A concern by some of the attendees was whether this was the appropriate group which would address the needs of the users in the marine environment who are concerned with precise positioning in support of oceanographic, hydrographic, and geophysical research activities. This was a group that was not adequately represented in the Civil GPS User Survey.

The discussion session was organized into five parts: (a) general information on scope and objectives, (b) abbreviations and definitions, (c) Civil GPS User Survey, (d) ICD, and (e) open discussion on other issues and concerns.

All discussion was limited to civil GPS data requirements.

The following summarizes comments and concerns made during each part of the discussion. In addition, attached are the written comments submitted by the attendees.

(2) Definitions and Abbreviations: In preparation for the discussion to follow, a list of common abbreviations were shown with an explanation of their meaning. These included: CGS, OPSCAP, CGIC, ICD, ICS, MCS, CSOC, and JPO. Additionally, definitions related to terms commonly used in geodetic and geophysical surveying applications of GPS were discussed. These terms included: Positioning methods (point, differential, and relative), mode of operations (static and kinematic), receiver types (code and codeless), observation data (pseudorange and carrier phase measurements), and range of accuracy requirements.

During this phase of the discussion it was emphasized that CGS will be the only interface between the civil users and military OPSCAP. It was also pointed out that work was only in the initial stages to develop the interface for disseminating the GPS information by the CGIC to the civil users.

(3) Civil GPS User Survey: Comments and/or concerns given during this period of the discussion were:

(a) So far, there appears to be inadequate representation by the user community involved in geodetic and geophysical surveying activities as characterized by the survey responses.

(b) Some attendees knew of users who did not respond because they did not receive the survey form until after the due date.

(c) The high representation among the professional users is consistent with the present breakdown in the user community.

(d) Some users may have not responded because they felt they had no apparent need for the CGS system; present use of the GPS system is going well; they may have felt they are self-sufficient; manufacturers have been their source for information on the GPS system.

(e) A manufacturing representative stated that he felt experienced users will want to rely on an official source for data and information such as the CGS.

(f) Users up until now may have had non-critical needs for the CGS such as post facto explanation of the GPS system anomalies, e.g., what was the cause for an out-of-service status for a particular satellite.

(g) A representative of the Ocean Drillers Association stated that this group has only recently met to determine their requirements and accuracies for use of GPS, thus their needs are not presently reflected in the survey.

(h) It was suggested that an article should be placed in the newsletter of the "American Geographic Oceanographers" soliciting input and comment.

(i) In response to a concern about disseminating useless information, it was stated that if some of the information that is initially made available to the user is not needed or not used, this would probably be dropped from the list of available data to help reduce costs in operating the CGIC.

(4) Interface Control Document: Comments and/or concerns given during this period of the discussion were:

(a) Time relevant data does not seem to warrant three levels -- two would suffice; delete the "short delay" level.

(b) In operating GPS survey systems, two levels of information and two levels of immediacy are required. First, it will be necessary to know that the GPS data will be accurate before going into the field and continues to be accurate and useful once on the job location; and second, post facto data and information about the system and its performance will be needed in the analysis stage -- this information must be precise, detailed, and reliable. The information needed before starting a project is critical because when the survey crew is deployed, it must be known with high confidence that there will not be a problem with the system that would cause the survey to be redone.

(c) As much as possible, the information available in the near realtime level should be reliable and complete enough for use in planning the final stages of a survey at least a month in advance.

(d) Ionospheric data in post facto level would be very useful to L1 only users.

(e) Post facto computed (precise) ephemerides was stressed as important and provisions should be made to insure this is available from CGIC. It should be available within two weeks of the last day of the orbit period.

(f) CGS should explore developing additional ICDs for other data sources that would be needed by civil GPS users, e.g., ionospheric data from the Air Force, precise ephemerides from non-civilian sources, carrier phase tracking data collected at continuously monitored stations established by civilian federal agencies.

(g) In regards to the post facto computed orbit data (precise ephemerides), there was concern about traceability. If there is a legal or official concern about the results of a GPS survey, will it be possible to get all the information needed to clearly describe how the orbit data was computed, what data was used, and the relationship of the orbit data for the period of concern with another period of time (e.g., two surveys that don't agree within expected tolerance: is it due to differences in the orbit data used or caused by something else?).

(h) It was suggested that dissemination of "global" relevant data must be inherently a government responsibility.

(i) Localized GPS survey operations (i.e., baseline measurements of within 100 km or so) can be handled effectively via relative positioning processes external to CGS, e.g., a network of points is established and tied to the National Geodetic Reference System to an accuracy of 0.1 ppm which may be 10 to 100 times the accuracy needed for the dependent surveys. Then the dependent surveys connected to this system can be easily evaluated and adjusted to meet most all survey needs. Receivers used might have 6-8 channels ensuring more than adequate carrier phase measurements even when there is a satellite failure.

(5) Other Issues and Concerns: The following comments and/or concerns were expressed:

(a) Will there be an ICD which defines what is being provided in the way of a precise ephemerides through the CGIC?

(b) In regards to the "nav message" that would be provided under the "short delay" level, there was a question as to its benefit. In response, it was stated that it would be a global set of readings from an array of receivers, compiled and disseminated to help users who would be dependent on the broadcast ephemerides to resolve any problems with these data.

(c) It was recommended that it might be helpful to get a 15-minute short term ephemerides with a fair amount of the SA effects removed.

(d) Issues regarding the GPS system that are local in scope may be addressed by commercial or private sources.

(6) Written Comments Provided by Attendees: See attachments.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Roger L. Merrell

AFFILIATION: Texas Department of Highways & Public Transportation

ADDRESS: Division of Automation
11th & Brazos Streets
Austin, TX 78701

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

Applications

Geodetic positioning for engineering related surveys. Relative differential mode with postprocessing. Also potential for realtime differential positioning of vehicles and positions of points with less accuracy than geodetic survey requirements.

CGS Services

(1) Provide primarily SV and system status as current as possible.

(2) CGS should have a broadcast capability (i.e., TTY) for quick modification of status changes to subscribers.

(3) Provide list of updated scheduled events to SV systems.

(4) Could provide an improved ephemeris after the fact.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Kevin Logan

AFFILIATION: U.S. Army Corps of Engineers

ADDRESS: U.S. Army Engineer Topographic Laboratories
CEETL-TL-SP
Fort Belvoir, VA 22060-5546

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

The following applications are generally what the individual Corps of Engineers Districts will be using GPS in their everyday assignments.

(1) Performing geodetic control surveys. These surveys range from first order to third order. The Districts need information to assist in project planning, and information to assist in postprocessing of the data.

(2) Dynamic Positioning. The Corps Districts are interested in using GPS in a differential mode for their hydrographic survey boats. Using GPS would eliminate the need for line-of-sight shore stations.

(3) Deformation studies. The Corps of Engineers is currently in the process of determining if GPS can be used as a continuous monitoring device for the movement of large structures (i.e., dams). A high precision network would be set up in the local area of a dam. Precision on the order of 5 mm or less will probably be needed.

Because the Corps of Engineers will be involved with the different applications listed above, information will be needed from near realtime for the dynamic position to post facto for the control surveys. I feel the Corps will be a large user of the CGS on a daily basis.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: L. Harold Spradley

AFFILIATION: GPS Technology Corporation

ADDRESS: 11999 Katy Freeway, Suite 320
Houston, TX 77079

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

(1) Geodetic control survey, network densification for geographical information system databases.

(2) Oil industry offshore survey (kinematic) in differential mode over 100-1000 km distances at 1:50,000 - 1:200,000 accuracy.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: W. Blanchard

AFFILIATION: Navigation Management Ltd.

ADDRESS: 43 Turret Grove
London SW4 OES
England

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

Offshore survey/positioning

Geodetic land positioning

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Norman Beck

AFFILIATION: Geodetic Survey of Canada

ADDRESS: 615 Booth Street
Ottawa, Canada K2L 2Z7

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

Applications

Precise relative positioning.

- Control networks of all scales
- Secondary networks

National GPS satellite tracking network and differential GPS Service

"Active Control System (ACS)" includes provision of

- Orbit determination
- Differential pseudoranges
- Unambiguous cycle slip free carrier phase data
- Ionospheric corrections

CGS could provide single source of information which would be passed on to ACS users.

- require information for planning
- information to understand alarm/warning/events
- on-line service and personal contact

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Charles N. Beal III

AFFILIATION: Naval Air Test Center

ADDRESS: RD61
Patuxent River, MD 20670

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

(1) Surveying, especially in remote locations.

(2) Time reference and time transfer.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Tony Jasumback

AFFILIATION: U.S. Forest Service, MEDC

ADDRESS: Fort Missoula
Missoula, MT 59801

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

Resource Management

(1) SV condition at time of use

(2) Future condition (status)

(3) Availability of precise ephemeris (2 weeks seems long)

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Karl Kovach

AFFILIATION: ARINC Research

ADDRESS: 4055 Hancock Street
San Diego, CA 92110

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

General and specific GPS applications/operations.

- If going to provide me with all the data needed to run an SV orbit Kalman filter, then can I request a copy (disk or 9-track tape) of the software used by the OCS Kalman filter?
(JOVIAL or FORTRAN - either would be okay).

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Paul D. Perreault

AFFILIATION: Trimble Navigation, Ltd

ADDRESS: 585 North Mary Avenue
Sunnyvale, CA 94086

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

As a manufacturer of GPS survey equipment:

(1) We need help in giving our users information on system status.

(2) Several users are now expressing their need for an NGS precise ephemeris (postprocessed) with less than a two week time delay.

(3) Since several of our clients operate all over the world, a multiplicity of output nodes for CGIC would help their operations (within the U.S. also).

(4) The short delay NAV message should not be the same as that broadcast but with some attempt to remove SA corruption. Perhaps the short delay is governed by security considerations, but in any case a "15 meter" type of ephemeris would be much more helpful to the community of surveyors.

(5) Those users operating at auroral latitudes ($60\text{-}70^{o}$) and near the dip equator would find helpful and necessary a source of ionospheric data for postprocessed data reduction. This data source should be global in nature and near realtime.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: Clive De La Fuente

AFFILIATION: Nottingham University

ADDRESS: Department of Civil Engineering
University Park
Nottingham
NG7 2RD
England

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

At Nottingham we are primarily involved with research covering geodesy, geophysics, pseudorange, and carrier phase positioning.

The main requirement for us as users would be STATUS information. A knowledge of when satellites are not going to be available, as well as a "hotline" for when something does go wrong. If the broadcast ephemeris is degraded as soon as possible afterwards a reasonable ephemeris would be required. A pure duplication of the broadcast ephemeris appears useless. A precise ephemeris would be useful for high accuracy work; this should be available as soon as possible after the observations. Carrier phase observations should be used in the determination of this ephemeris.

PROPOSED APPLICATIONS OF GPS
AND SPECIFIC AREAS OF INTEREST

NAME: H. J. W. Van der Vegt

AFFILIATION: Survey Department

ADDRESS: Rykswaterstaat
P. O. Box 5023
2600 GA Delft
The Netherlands

In the space provided below please describe your specific applications for GPS and requirements you foresee which could be fulfilled by the Civil GPS Service.

Applications

- Geodetic surveying
- Photogrammetry
- Positioning/navigation
  - sub meter dynamic differential (relative)
- routing/transport control

(1) Dynamic photogrammetric applications, a need for 15 m accuracy is near realtime

(2) Marine surveying
- near realtime 15 m accuracy

(3) Geodetic survey
- 10^{-6} or better needs for post facto (1-2 weeks) precise ephemeris
- alarm/warning/events realtime

NAVIGATION / AVIATION / AEROSPACE

GENERAL APPLICATIONS:

NAVIGATION

POSITION LOCATION

TYPES OF USERS:

GENERAL AVIATION

COMMERCIAL AVIATION, AIR TAXIS, HELICOPTER, ETC.

AEROSPACE

METHODS OF SOLUTION:

POINT POSITIONING

DIFFERENTIAL POSITIONING (REAL)

RELATIVE POSITIONING (POST)

SPECIFIC APPLICATIONS:

AVIATION - PHASES OF FLIGHT (ENROUTE, TRANSITION, APPROACH, ETC) TEST, INSTRUMENTATION, RANGE SAFETY, OTHER SAFETY-RELATED CONCERNS

AEROSPACE - LAUNCH, MID-COURSE, IN-ORBIT OPERATIONS, EPHEMERIS DETERMINATION, TEST AND INSTRUMENTATION, RANGE SAFETY, AND RELATED APPLICATIONS

NAVIGATION/AVIATION/AEROSPACE
DISCUSSION GROUP

DISCUSSION TOPICS

This session addresses the aviation and aerospace applications of GPS operating in its SPS mode and includes differential (code) uses as well as some carrier phase measurement techniques. The areas of interest include both point positioning and aided implementations of GPS. In the aviation field, GPS applications include enroute, terminal/transition, and non-precision approach phases of flight, as well as future precision approach and landing capabilities. Related applications include test and instrumentation, separation assurance/collision avoidance, and other safety-related concerns.

Aerospace applications for GPS include launch, mid-course, and in-orbit operations as well as ephemeris determination, test and instrumentation uses, and range safety and related applications.

TECHNICAL DISCUSSION SUMMARY
NAVIGATION/AVIATION/AEROSPACE

MR. KEITH MCDONALD, CHAIRMAN
FEDERAL AVIATION ADMINISTRATION

Thirty attendees were present. The following issues were identified for which the foregoing comments and recommendations were made.

(1) Categorization of timeframes for CGS data:
   (I) Predictions: Immediate access. Notices/scheduled events/prediction data (new category).
   (II) Short Delay: 30-60 minutes. Alarm/Warning/Event message blocks (former near realtime transfer)
   (III) Medium Delay: 1-2 hours. Includes all items previously listed under "short delay transfer".
   (IV) Long Delay: 2 days plus. Includes all items previously listed under "post facto transfer".

(2) Concern was raised relating to the start point for the CGS data timeframes. In particular, should start be measured from time of occurrence or time of recognition?

   RESOLUTION: From time of recognition.

(3) The group agreed that the items normally provided in the GPS data message should be retrieved and made available through the CGS to the civil community. This information should be comprehensive (worldwide) and therefore should come from the Military Operational Control System.

(4) The entire group was found to consist of those concerned with aviation. There were no attendees representing the space

community. No space-based system requirements for the CGS distribution were identified.

(5) In response to identifying requirements for the civil air carriers, it was stated that the airlines should be able to receive updated GPS information, including ephemeris and purposes. Similar information would probably be desired by the FAA Air Traffic Services people. These data would be generally Type I or Type II data.

(6) It was decided that postprocessed ephemeris information would be helpful for many aviation users in that this would allow a more accurate determination of actual position. This would imply basic recordkeeping by the user and may provide benefits to aviation users similar to those currently provided to the survey community.

RESOLUTION: Recommend that GPS postprocessed information from the OCS be made available for general aviation and other users.

(7) Issue: Formatting of the information to be provided by the CGS to the civilian community. Although the data format from the military OPSCAP to the CGS has been addressed in the ICD, it is necessary to define the format and criteria for data distribution from the CGS.

(8) Issue: Cost of the CGS information. It should be self-supporting with a reasonable cost arrangement such as the following.

(a) For every access period, a certain charge.

(b) Trust fund for aviation users.

(c) Normally free and a government service (as with many Coast Guard navigation services).

We did not arrive at guidelines for pricing of the service, but addressed several options.

RESOLUTION: Cost should be moderate and should not inhibit use. It is recommended that CGS information for safety services be made free, and a charge be made for other services (such as postprocessed information).

(9) Issue: NOTAM System role vis-a-vis CGS.

RESOLUTION: It is recognized that the Aviation NOTAM process will provide the required safety information to pilots and that the CGS will basically provide other data to the aviation community.

ATTENDANCE LIST

Phillip J. Klass	Aviation Week	Washington, D.C.
Capt. Mark W. Erkkila	Space Div/CWNG	LAAFB, CA
Maj. Bill Freeland	2d Space Wing/DO	Falcon AFS, CO
Ron Walsh	IBM	Gaithersburg, MD
Paul Braisted	Trimble Navigation	Sunnyvale, CA
John Nielson	Boeing Aerospace Co.	Kent, WA
Mark O'Hara	IBM	Gaithersburg, MD
Karen Colton	ARINC Research	SDCA
Ronald Braff	MITRE Corp	McLean, VA
W. Rhodus	AEROSIACG	Los Angeles, CA
P. R. Pastor	ARL:UT	Austin, TX
Walter Murch	SAIC	Hermosa Beach, CA
Joshua Elitzur	SAIC	Camarillo, CA
L. R. Sugerman	PSL/NMSU	Las Cruces, NM
P. Jorgensen	AEROSPACE Corporation	Los Angeles, CA
N. Hemesath	Rockwell International	Cedar Rapids, IA
Tom Damiani	Rockwell International	Seal Beach, CA
Ralph D. Sexton	FAA/AVN	Oklahoma City, OK
Art Cox	U.S. Navy	Pt. Mugu, CA
Larry Reusser	FAA	Oklahoma City, OK
Don Krause	FAA	Oklahoma City, OK
Gary Baird	FAA	Oklahoma City, OK
Gene Wong	FAA	Washington, D.C.
Young C. Lee	MITRE Corporation	McLean, VA
Edward C. Rish	Synetics, Inc.	Vienna, VA
Col. Gene Coco	GPS Joint Program Office	Los Angeles, CA
N. A. Tony Pealer	Systems Control Tech.	Washington, D.C.
Keith McDonald	DOT/FAA	Washington, D.C.

NAVIGATION / MARINE

GENERAL APPLICATIONS:

NAVIGATION

TYPES OF USERS:

COMMERCIAL SHIPPING

PLEASURE BOATERS

FISHING INDUSTRY USERS

MARINE RESEARCH

METHODS OF SOLUTION:

DIFFERENTIAL POSITIONING (REAL)

RELATIVE POSITIONING (POST)

SPECIFIC APPLICATIONS:

HARBOR ENTRANCE

RIVER NAVIGATION

NAVIGATION/MARINE
DISCUSSION GROUP

DISCUSSION TOPICS

This session is oriented to the discussion of GPS as used in marine navigation applications. GPS marine navigation includes commercial shipping, pleasure boaters, and fishing industry users. The meeting will discuss GPS capabilities available to marine navigation users. The information on GPS status that marine users require will be considered along with how marine users would obtain this information, e.g., rf broadcast. Discussion will include topics of differential positioning with reference to harbor entrance and river navigation.

TECHNICAL DISCUSSION SUMMARY
NAVIGATION MARINE

CDR RICHARD HENDRICKSON, CHAIRMAN
U.S. COAST GUARD

The Maritime Users Discussion Group consisted of the following: CDR Richard G. Hendrickson, GPS Joint Program Office, Chairman; Dr. Leonard Kruczynski, Trimble Navigation; Mr. J. H. M. van der Wal, Netherlands Ministry of Transport; Ms. Valerie Wong, Magellan Systems Corporation; and Mr. Bart Ewers, ARINC.

The Maritime users are mainly interested in information concerning areas of degraded coverage, particularly in bays and harbors where precise navigation is important. Other interests include scheduled events which might cause degraded coverage, and significant events such as the launch of a new satellite, as well as the realtime information which would be provided by the receiver.

It is generally felt that the recreational user and the fishing industry will not require a great deal of information, but will demand that the information be kept simple, and in a format that is readily understandable by whomever is navigating the vessel. These users will require that GPS status information be made available, prior to their voyage, through a telephone call to a recorded message, or possibly through a computer terminal aboard their vessel or at the harbormaster's office.

During the voyage, GPS status information provided via the current Marine Information Broadcasts, made twice daily by the U.S. Coast Guard by voice and radioteletype, would satisfy normal requirements.

Those vessels making international voyages would probably require information in areas not covered by the USCG broadcasts, and could

receive this information via the Automated Notice to Mariners broadcasts, or through the broadcasts made through facilities of the Global Maritime Distress and Safety System.

Maritime users would normally only be interested in areas of degraded coverage based upon a 3-satellite, altitude-hold solution.

NAVIGATION AND POSITIONING / LAND

GENERAL APPLICATIONS:

NAVIGATION

POSITION LOCATION

TYPES OF USERS:

LAND -

- TRUCKING / RAILROADS
- AUTO / BUS FLEETS
- PUBLIC SAFETY
- LEGAL / RECORDKEEPING

METHODS OF SOLUTION:

DIFFERENTIAL POSITIONING (REAL)

RELATIVE POSITIONING (POST)

SPECIFIC APPLICATIONS:

AUTOMATIC VEHICLE LOCATION

POSITION MONITORING SYSTEMS

SEARCH AND RESCUE, e.g., LOST HIKERS

NAVIGATION AND POSITIONING/LAND DISCUSSION GROUP

DISCUSSION TOPICS

This session is oriented to the discussion of GPS used in land navigation and positioning applications. Such applications would include the navigation of people and vehicles, e.g., automobiles and ATVs, in both urban, suburban, and remote areas. It will also include the positioning applications such as automatic vehicle location and monitoring systems used in the trucking and railroad industry. Future applications such as search and rescue, e.g., lost hikers, will also be discussed. The chairman will then ask the participants in this session what they foresee as their requirements from a Civil GPS Service.

TECHNICAL DISCUSSION SUMMARY
NAVIGATION AND POSITIONING/LAND

MR. DAVID SCULL, CHAIRMAN
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
U.S. DEPARTMENT OF TRANSPORTATION

Prior to summarizing the Navigation and Positioning/Land discussion, I would like to clarify the role of DOT with respect to the Civil GPS Service. Speaking as chairman of the DOT Navigation Working Group, I think it is important to emphasize that DOT will assume a key role in implementation of the CGS. This will require coordination with other government agencies and departments such as Department of Commerce, Department of Interior, and Defense Mapping Agency. I think it is important to state that DOT's statutory responsibility relates to transportation issues. NGS, for instance, certainly has the responsibility to the geodetic community. Again, however, DOT does intend to take the key role with respect to the CGS.

The Navigation and Positioning/Land discussion group would like to make the following three recommendations that the CGS should

(1) promote standards,
(2) serve as an advocate for the civil user, and
(3) provide information.

First, we'd like to see the CGS promote standards; particularly with respect to differential GPS. We would also recommend that the CGS promote standards for such applications as railway management and additional applications which will exist in the fields of aviation and maritime use.

Secondly, we recommend that this organization serve as an advocate, a spokesman, for the civil users.

Our third recommendation is for the CGS to provide information. Various means of disseminating information would include electronic bulletin boards, pamphlets, and newsletters. It was suggested that the use of a satellite communications link might be employed for transmission of such information as differential GPS. It was also pointed out, however, that under some circumstances the opportunity to personally speak with an individual would be desirable.

CIVIL GPS USER
WORKSHOP CONCLUSIONS

Eighty-seven people attended the workshop and provided inputs via the five working groups.

Representatives from DoD and DOT presented information on the policy and mechanism for providing data to the civil community. ARL:UT presented a review of the development of CGS and reviewed in detail the Interface Control Document (ICD) describing the data exchange between the ORMS and CGS.

Highlights from the workshop are summarized below.

CGS SHOULD BE THE CIVIL POINT OF CONTACT AND SERVE AS AN ADVOCATE FOR CIVIL USERS

The GPS is a DoD development and the civil community has been given access to it through a resolution of the Federal Radionavigation Plan (FRP). The requirements of the civil community need to be reviewed and changes presented to DoD and the Congress. This organization, directed by DOT, should be the advocate for the civil community on these issues.

One example, from the civil time/frequency community in regard to selective availability, is cited below.

> **Securing access to an undegraded satellite to avoid impact of selective availability on the time/frequency community.**

One satellite, or even two, maintained in the undegraded mode will not override the limited navigation accuracy to be provided by DoD to the civil community, but would provide a method to maintain worldwide high accuracy timing and time transfer to the civil community.

CGS SHOULD PROVIDE A DATABASE LARGE ENOUGH TO HANDLE INFORMATION ON BOTH A GENERAL AND SPECIFIC BASIS, INCLUDING PUBLISHING GENERAL GPS INFORMATION

The database to be provided to the user by CGS should be sufficient to meet the needs of the general user as well as the needs of the professional user. This information should be provided to each group in a "user friendly" format to promote user inquiry. Tutorial information about the GPS system should be provided as printed material for dissemination to the user community.

CGS SHOULD PROVIDE TRACEABILITY OF DATA AND PROMOTE STANDARDS

To satisfy legal requirements the data provided through CGS must be traceable for legal issues. These data could be used by private companies that will provide a service based on the data. If the service results were questioned, the source and accuracy of the data received from CGS must be known. The promotion of standards follow this requirement. Standards within the user community on data, equipment, and services must be established and maintained.

V. GPS CIVIL USER WORKSHOP
22 SEPTEMBER 1987

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AVIATION	3
SURVEYING	1
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